Scientific Revolutions -
A First Year Seminar Course Design

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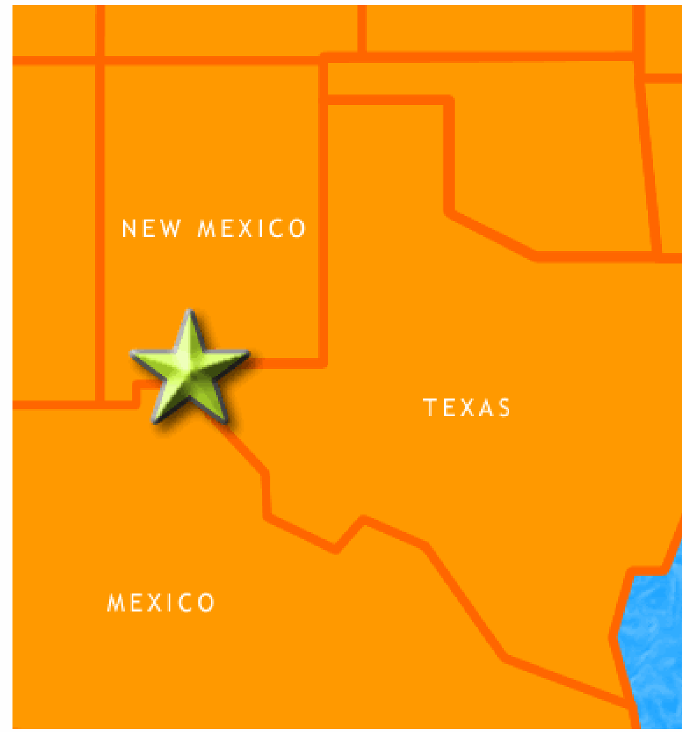
Overview

1. The University of Texas at El Paso
2. The FYS at UTEP
3. Theme: “Scientific Revolutions”

UTEP Student Profile

About 25,000 students

(21,300 UG and 3,700 GR)



- 24 years of age (undergraduate average)
- 80% Hispanic (+4% Mexican)
- 54% female
- 84% from El Paso County commuting daily
- 81% employed
- 55% first generation university students

(Fall 2017)

Carnegie R1 institution

UNIV 1301

- Started about 20 years ago
- Until recently a required course for all incoming freshmen (there is an alternative course UNIV 2350 for transfer students)
- Now UNIV 1301 is one of seven options (other choices include BUSN, COMM, CS and SCI)
- About 2500 students take the course in the fall semester
- About 90 sections, max. 28 students per section

UNIV 1301 – Course Goals

Students will:

- examine the roles and responsibilities crucial for success in college.
- practice essential academic success skills.
- build a network of faculty, staff and peers.
- assess and understand their interests, abilities, and values.
- become involved in UTEP activities and utilize campus resources.

UNIV 1301 – Course Setup

The course consists of two parts:

- About 50% of the course is devoted to student “survival” skills.
- The rest of the course is dedicated to a “theme”, picked by the instructor.

- Some course sections are intended for all majors, some have a restricted intended audience.
- The instructional team consists of the instructor, a peer leader, a librarian and an academic advisor.

Theme: Scientific Revolutions

- Intended audience: STEM majors simultaneously taking a developmental mathematics course

Theme: Scientific Revolutions

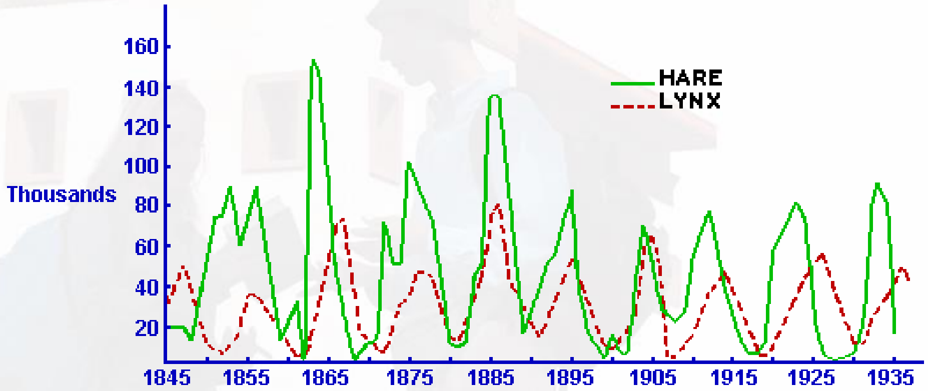
Science history as a "hook" for studying functions via difference equations:

"The simplicity of nature is not to be measured by that of our conceptions. Infinitely varied in its effects, nature is simple only in its causes, and its economy consists in producing a great number of phenomena, often very complicated, by means of a small number of general laws."

Theme: Scientific Revolutions

Topics:

- Galileo – linear versus quadratic functions
- Copernicus/Kepler – power functions
- Malthus/Fibonacci – exponential growth, quadratic functions, limits
- Logistic growth, predator-prey models
- Mendel/Hardy-Weinberg – probability, limits



Theme: Scientific Revolutions

Extensive use of Excel spreadsheets:

- They are the perfect tool to visualize the solutions of difference equations
- They allow to cover more advanced subjects by reducing the amount of algebra needed by the students

Introductory: Linear Models

Converting temperature from $^{\circ}$C to $^{\circ}$F

The defining ingredients:

"Initial Data"

- 0 $^{\circ}$C corresponds to 32 $^{\circ}$F

"Difference Equation"

- Every 1 degree increase in $^{\circ}$C corresponds to a 1.8 degree increase in $^{\circ}$F

Temperature Conversion

c	f
0	32.0
1	33.8
2	35.6
3	37.4
4	39.2
5	41.0
6	42.8
7	44.6
8	46.4

Initial Data

f(5)
= f(4)+1.8
= 39.2+1.8
= 41.0

Example: Exponential Growth

n	P(n)
0	5000
1	5500
2	6050
3	6655
4	7321
5	8053
6	8858
7	9744
8	10718

Data on the left are in “**arithmetic progression**” (= constant differences between consecutive terms)

Data on the right are in “**geometric progression**” (= constant ratios between consecutive terms)

Example: Geometric Progression

Student Activity

- Fill in the missing data in the table on the right such that the y-data are in geometric progression:

x	y
0.0	1.000
0.5	
1.0	2.000
1.5	
2.0	4.000
2.5	
3.0	8.000

Example: Exponential Growth

Fibonacci Numbers

n	R(n)	R(n)/R(n-1)	n	R(n)	R(n)/R(n-1)
0	1		11	144	1.6179775
1	1	1.0000000	12	233	1.6180556
2	2	2.0000000	13	377	1.6180258
3	3	1.5000000	14	610	1.6180371
4	5	1.6666667	15	987	1.6180328
5	8	1.6000000	16	1597	1.6180344
6	13	1.6250000	17	2584	1.6180338
7	21	1.6153846	18	4181	1.6180341
8	34	1.6190476	19	6765	1.6180340
9	55	1.6176471	20	10946	1.6180340
10	89	1.6181818	21	17711	1.6180340

Example: The Golden Ratio

Cheating, by assuming that the ratio r of consecutive terms is eventually constant, we can compute r:

- r = R(n+2)/R(n+1) = R(n+1)/R(n)
- Using R(n+2)=R(n+1)+R(n), we obtain

$$r = 1 + 1/r, \quad \text{i.e.} \quad r^2 - r - 1 = 0$$

- Solving for r yields the "Golden Ratio" as the positive solution:

$$r = \frac{1}{2}(1 + \sqrt{5}) = 1.61803399$$

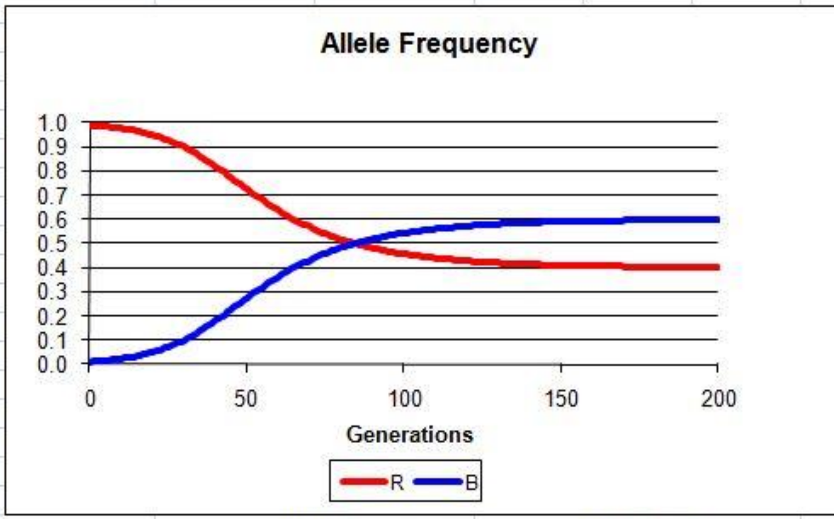
Example: Hardy-Weinberg

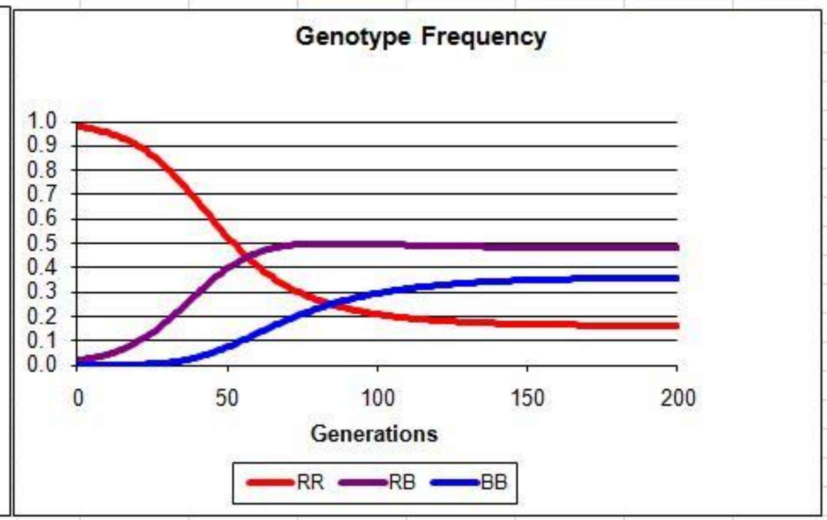
J3 fx =1-J2

The Hardy-Weinberg Law with Natural Selection

Change the pale blue cells to try different scenarios.

initial allele ratio	R	0.990
	B	0.010
relative survival rates	RR	1.000
	RB	1.090
	BB	1.030





	Alleles		Genotypes			
Generation	R	B	RR	RB	BB	
0	0.990	0.010	0.980	0.020	0.000	1.002
1	0.989	0.011	0.978	0.022	0.000	1.002
2	0.988	0.012	0.976	0.023	0.000	1.002
3	0.987	0.013	0.974	0.025	0.000	1.002
4	0.986	0.014	0.972	0.028	0.000	1.002
5	0.985	0.015	0.970	0.030	0.000	1.003
6	0.984	0.016	0.967	0.032	0.000	1.003

References

Dan Kalman, *Elementary Mathematical Models*. Mathematical Association of America, 1997

UNIV 1301 Master List (Fall 2018)
[www.utep.edu/esp/_Files/docs/students/Univ1301MasterList.pdf]

Contact Info

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