

“Teaching Statistics for Critical Engagement Beyond Classroom Walls”

ICOTS-9 invited session 7A (see my 6-page paper in ICOTS9 proceedings)

Dr. Lawrence M. Lesser

The University of Texas at El Paso

Lesser@utep.edu



supported in part by Project UPLIFT (NSF/EHR/DUE #1140690)



presentation outline

- Motivations/importance
- Framework
- Examples
- Benefits
- Future directions
- Q & A

motivations & importance

- Improve our own students' motivation and engagement (UCLA study: 40%+ frequently bored in class)
- Supplement/alternative to F2F teaching
- Outreach to the broader public (e.g., ASA, CAUSE, Statistics2013, World of Statistics)
- A way to show “data are not just numbers, they are numbers with a context” (Cobb & Moore, 1997)
- Session 7A themes(lifelong learning, etc.)

Informal Science Education classification of out-of-classroom experiences (Braund & Reiss, 2006)

- The actual world
- A presented world
- A virtual world

“a synchronous, persistent network of people, represented as avatars, facilitated by networked computers” (Bell, 2008)

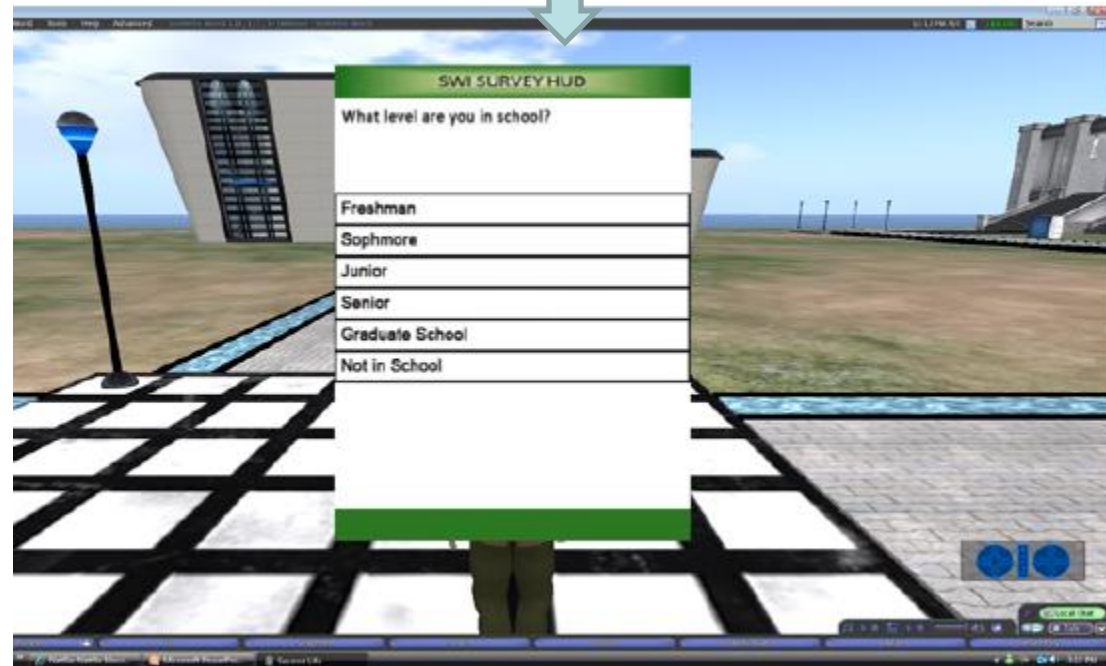
presentation outline

- Motivations/importance
- Framework
- Examples
- Benefits
- Future directions
- Q & A

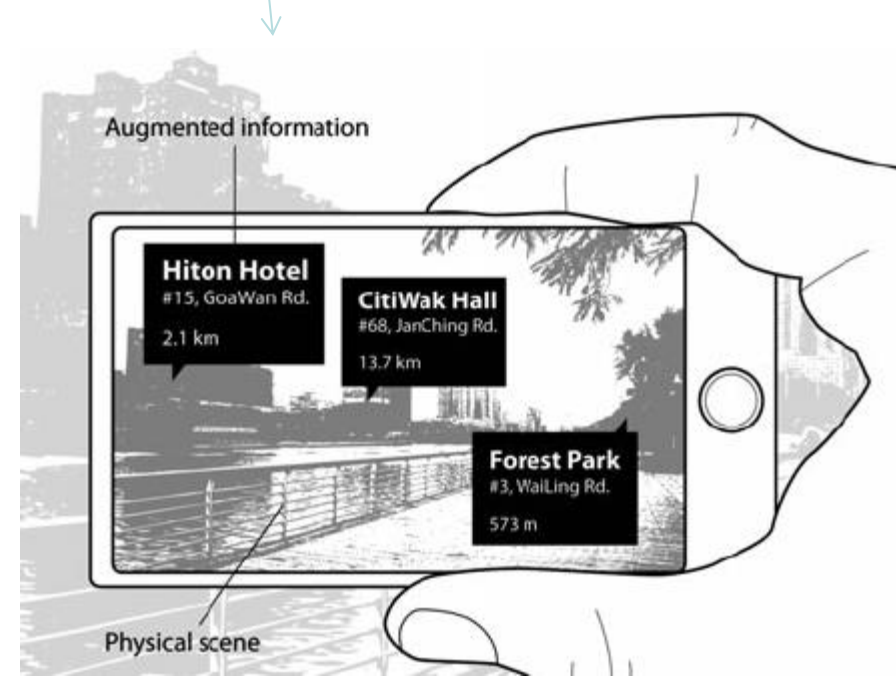
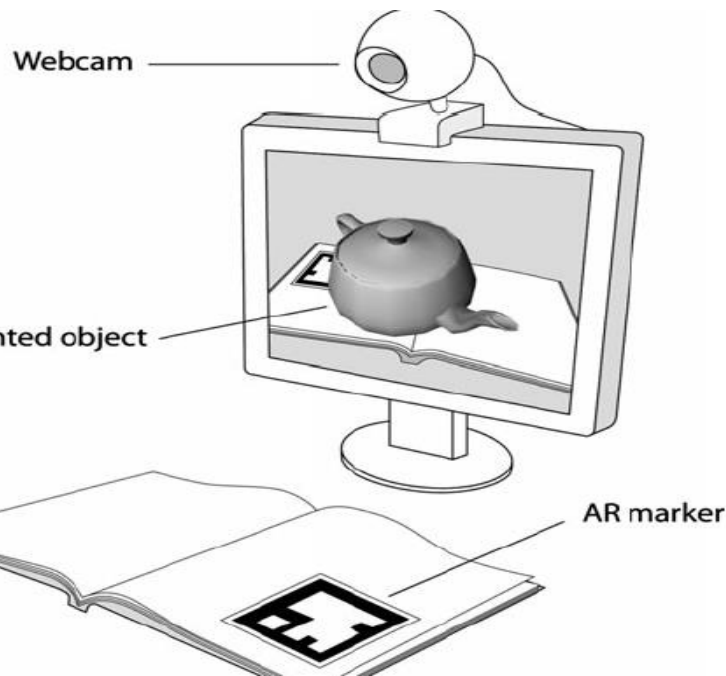
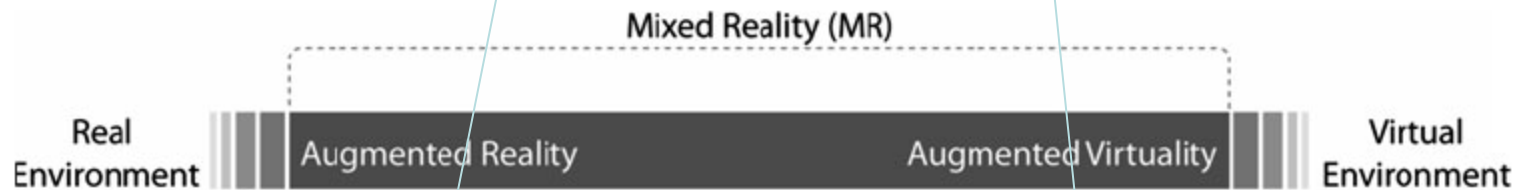
Virtual World: An Example

Practice sampling/survey/interview techniques in **SecondLife.com** (Bell, Castronova, Wagner, 2011):

Virtual Data Collection Interface(VDCI) Heads-Up Display (HUD) displays survey (via “survey kiosk”) then records participant’s answer



Augmented Reality(AR) connects Virtual and Actual World,
can be image-based or location(e.g.,GPS)-based
(figures from Cheng & Tsai, 2013)



ideas for Augmented Reality (AR)

Statistics textbook marker label
activates via webcam capture
a virtual element to explore a 3-D
scatterplot or distribution (by tilting and
rotating the book)

superimpose data on mobile devices
based on position

Presented World example: Museums

Science (e.g., Exploratorium) and
Math (National Museum of Mathematics)
museums now include
statistics/probability exhibits
(e.g., MoMath's Edge FX Galton board
which includes lever that lets you
select where the balls fall)



SANKHYĀ National Museum of **Statistics**
to open at Univ. of Hyderabad (India)

Presented World example: Museums/Libraries

Beyond exhibits: classes

Celebration events

UNSD launched quinquennial World Statistics Day 2010;
International Year of Statistics 2013 → World of Statistics;
February's Random Acts of Kindness Week:



Presented World: Videos, TV, Radio, Podcasts

COMAP(1989) *Against All Odds*

statsandstories.net (Miami University)

NBC Learn

Mythbusters (e.g., “3 doors game” episode)

amstat.org/youtube/

Khan Academy

Presented world: my 2012 episode on polls and surveys on local PBS-TV show “Blast Beyond”



Presented World: Songs (on CAUSEweb.org)

TITLE	TOPIC
Call Me It Maybe	variation
Mean	median better than mean for data with skewness/outliers
The Gambler	lottery literacy
MLE Let it Be	MLE properties
Hit Me with Your Best Shot Plot	graphing
Mexican Y Hat Dance	line of fit (notation & process)
Happy Birthday to You Song	Birthday Problem
One is the Loneliest Likeliest Number	Benford's law
1 in 2	equiprobability bias

Actual World example: Data Collection Field Trips

Relate observations on **community walk**

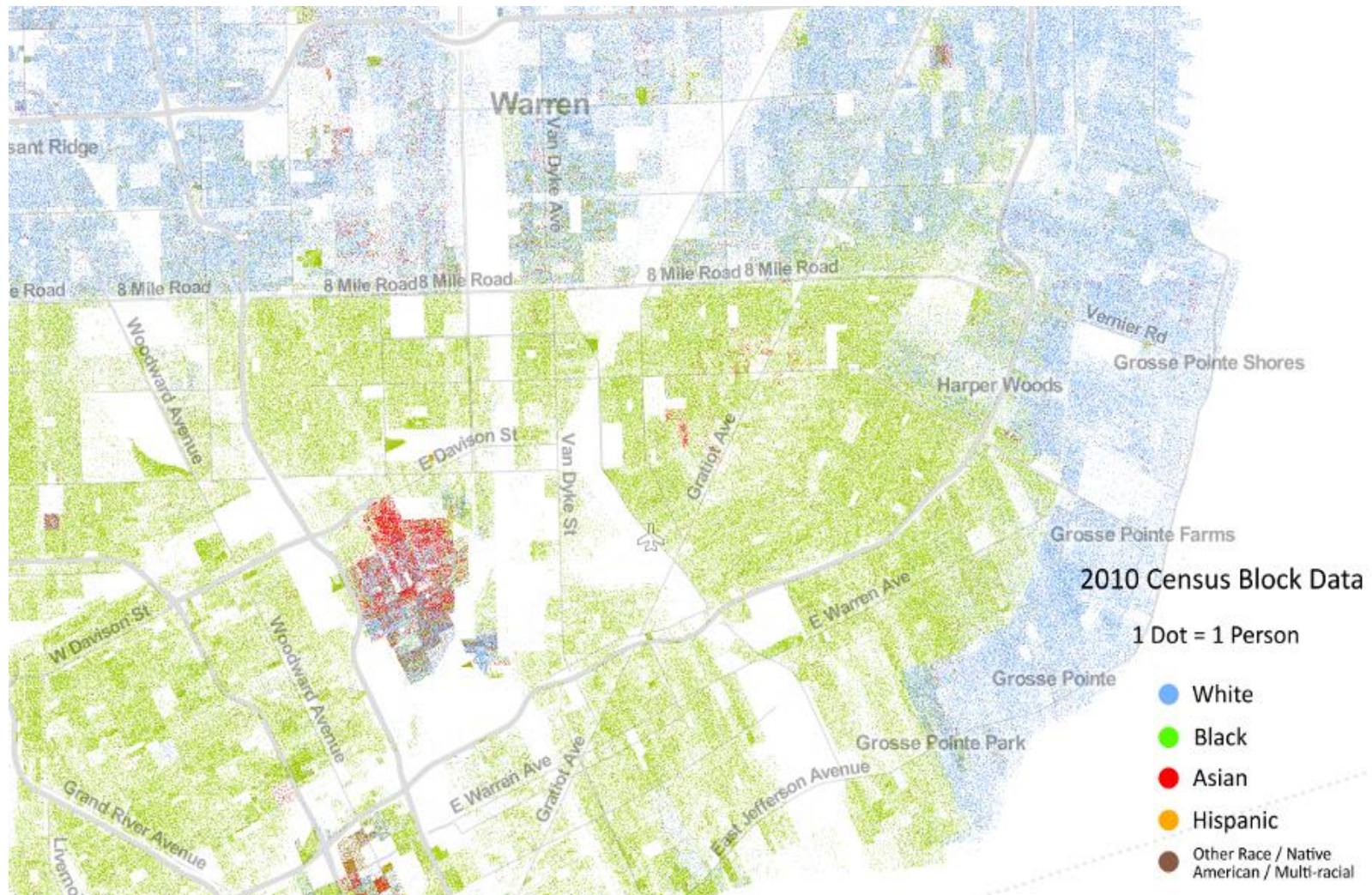
(Rubel, Chu, Shookhoff, 2011)

to data from <http://factfinder2.census.gov>,
<http://epa.gov/myenvironment/> (air, water, pollutants, etc.),

GIS data from myworldgis.org (Enyedy's
Community Mapping Project),
Racial Dot Map, etc.

Racial Dot Map

<http://demographics.coopercenter.org/DotMap/>



Actual World example: adult education outreach on Texas Lottery

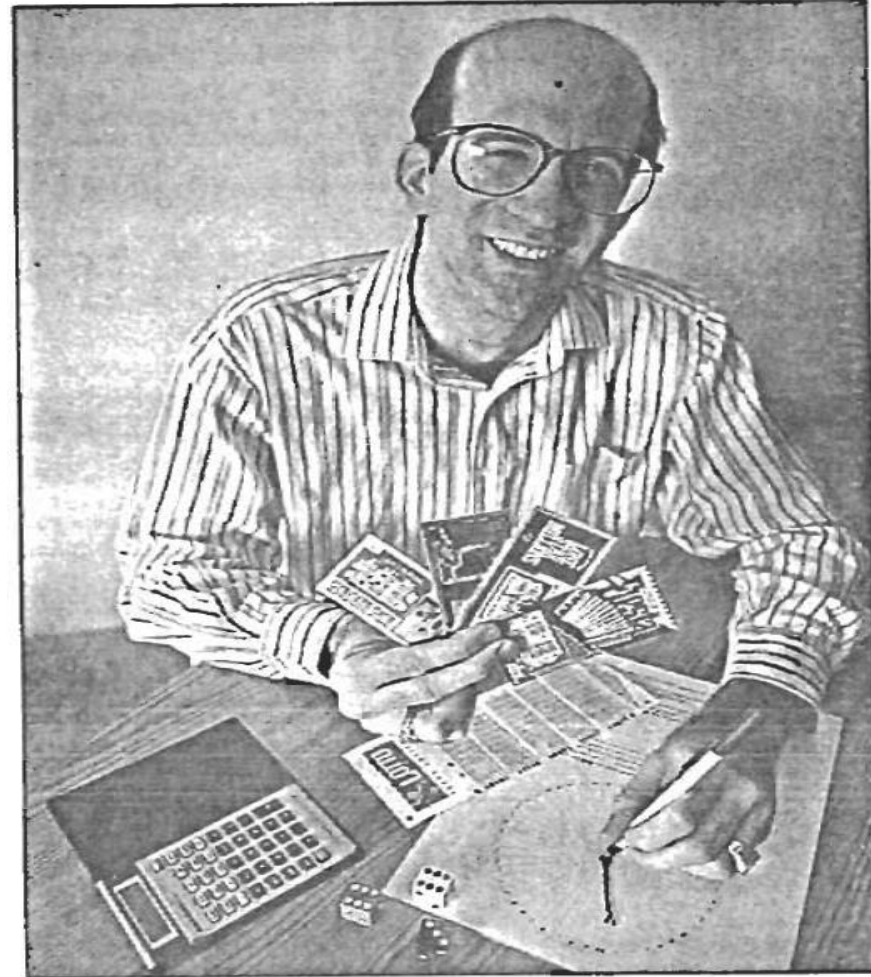
- adult education courses (UT-Austin, UT-El Paso)
- pieces in 5 education journals:

<i>J. of Statistics Education</i>	March 2013
<i>Mathematics Teacher</i>	Sept. 2012
<i>Statistics Teacher Network</i>	Winter 2004
<i>Texas Mathematics Teacher</i>	Fall 2003
<i>Spreadsheet User</i>	Nov. 1997

- TV/radio/magazine interviews
- (award-winning) YouTube video
- Lottery Literacy webpage
<http://www.math.utep.edu/Faculty/lessor/lottery.html>
- song parody “The Gambler”

Saturday, August 28, 1993

Austin American-Statesman **B3**



Staff photo by Lynne Dobson
Larry Lesser, a St. Edward's University professor, hopes to demystify the numbers surrounding the Texas Lottery in a class he will be teaching.

Actual World example: culturally relevant family math learning event

(Ramirez & McCollough, 2012)

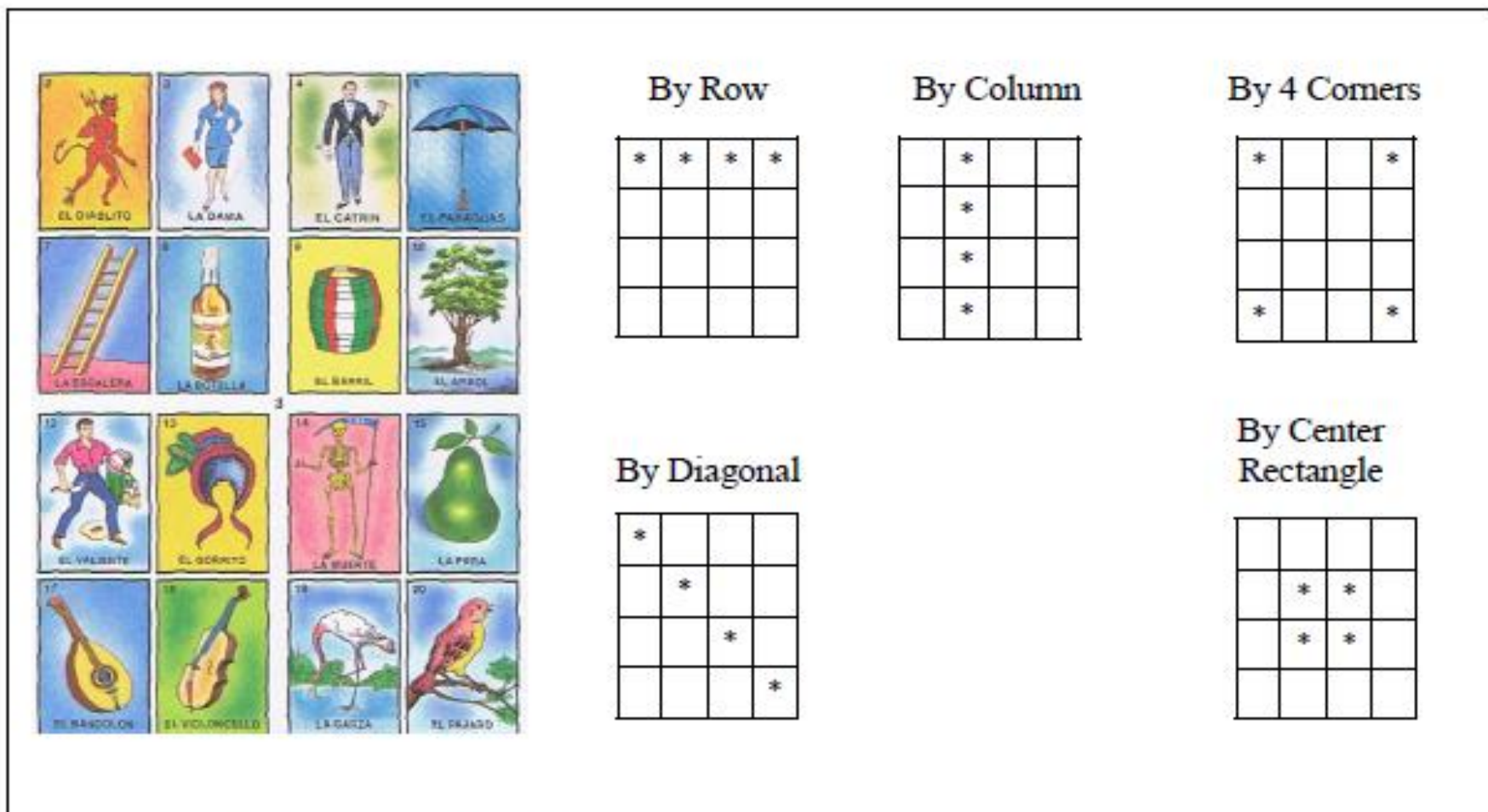


Figure 1. Sample "La Loteria" board and types of winning moves.

La Lotería questions

(Ramirez & McCollough, 2012; Lesser 2013)

- How many ways to win?
- How many different 4x4 boards are there if the 16 cells must be different and drawn from a set of 54 images?
- What's [largest; **smallest**] number of cards dealer could call before your board [must; **could**] win?
- What's $\Pr(\text{neither of first 2 cards called are on your 4x4 board})$?

the Mexican game of Toma Todo



face of <i>pirinola</i>	result (S = spinner)
Toma Todo	S takes all
Toma Uno	S takes 1
Toma Dos	S takes 2
Pon Uno	S puts in 1
Pon Dos	S puts in 2
Todos Ponon	Each puts in 2

Toma Todo questions (Lesser 2010)

- If pot starts with N chips (say, 2 from each player), what is the EV of what is won by the player doing the very first spin?
- Does the *second* player to spin have expected winnings that are less, more or the same as the first player?

(Hanukkah) *dreidel* game



face of dreidel	Action (S = spinner)
Gimel	S gets all
Hay	S gets half
Nun	nothing
Shin	S puts in 1

Actual World example: sports/games

statistics courses on sports (Tabor & Franklin, 2012; Wiesner, 2013) or a particular sport such as baseball (Albert, 2003; Rothman, 2012)

Shonda Kuiper's NSF project "games with a purpose":

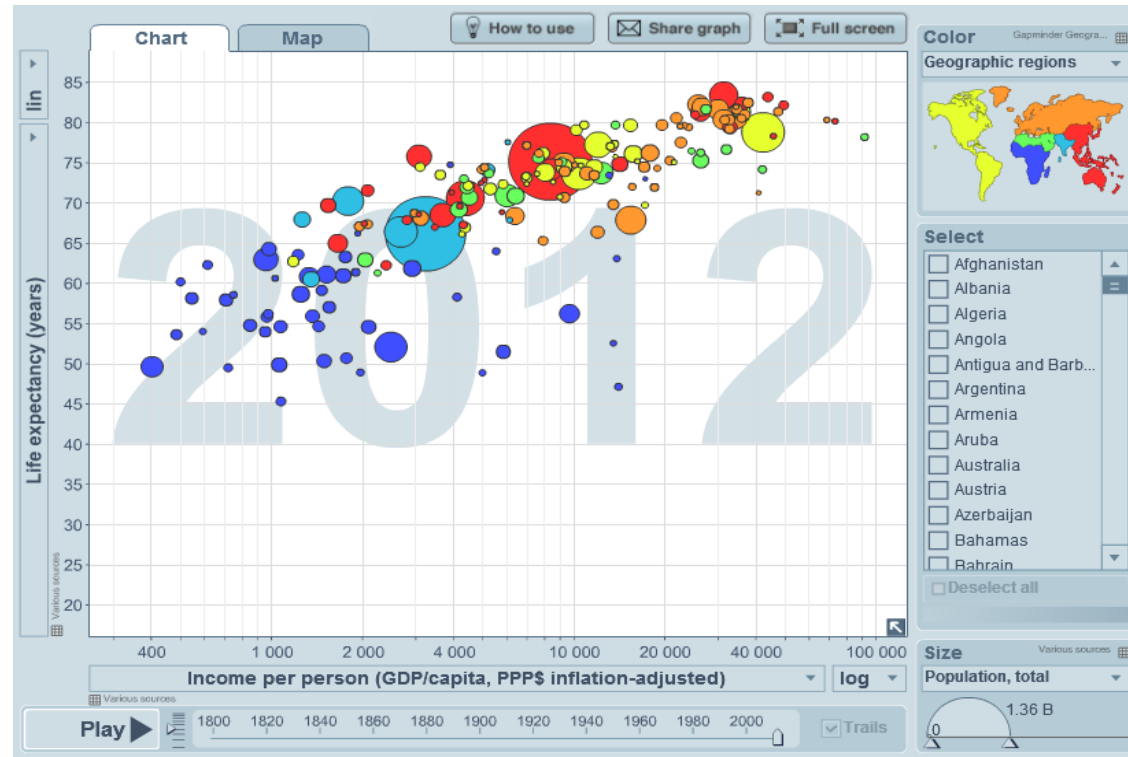
<http://web.grinnell.edu/individuals/kuipers/stat2labs/Labs.html>

Actual World example: engaged citizenship

Social justice (e.g., Lesser in March 2007 *JSE*)

Service learning (e.g., Amy Phelps in Nov. 2012 *JSE*)

Gapminder.org



presentation outline

- Motivations/importance
- Framework
- Examples
- **Benefits**
- Future directions
- Q & A

BENEFITS of out-of-class experiences

Students own/control learning by hitting
pause/rewind, take in more info
through multiple input channels (Petty, 2010)

Extended practical work, active learning
Motivation

Contextualize, set up, and increase time
for (flipped) in-class experiences

Hone teacher skills to cultivate engagement,
incorporate questions, make real-world
connections, tailor to student backgrounds

Benefits of out-of-classroom contexts (Braund & Reiss, 2006)

- Improved development and integration of concepts
- Extended and authentic practical work
- Access to rare material and to “big” science **data**
- Attitudes to school science: stimulating further learning
- Social outcomes: collaborative work and responsibility for learning

pitfalls of informal contexts

- Learning may not be substantial
- Misconceptions may be initiated/fostered
- Agenda may be on engagement more than on educational gains

FUTURE DIRECTIONS

Address the pitfalls on the previous slide

Broaden collection (e.g., add non-US examples)

Give implementation guidelines

Collect data on examples' effectiveness to motivate learning, improve attitudes, decrease anxiety towards statistics

[one result ($p = .04$) from our NSF study:

exposure to songs in LMS increased learning;

see ICOTS9 poster #40 and eCOTS breakout session]

Thank you for coming!

QUESTIONS?

“Teaching Statistics for
Engagement
Beyond Classroom Walls”

Dr. Lawrence M. Lesser

The University of Texas at El Paso

Lesser@utep.edu



“It’s a Sign: A Connection between Correlation and Slope”

(students randomly assigned to include the **red** part or not)

The correlation coefficient r tells us something about the strength and linear relationship of a scatterplot of data. By strength, we mean how tightly the points cluster around the regression line (i.e., the line of best fit). All else being equal, a correlation value of $r = .7$ (or $r = -.7$) generally indicates a stronger linear relationship than a value such as $r = .3$ (or $r = -.3$).

The direction of the relationship has to do with the sign of r . If $r > 0$, we have positive correlation, which means higher values of Y are associated with higher values of X , and lower values of Y are associated with lower values of X . In other words, X and Y go up and down together. Such a scatterplot would be described best with a line of fit that has a positive slope, and indeed this is always the case: positive correlation happens when the regression line slope is positive. Likewise, $r < 0$ means negative correlation, with X and Y moving in opposite directions from each other, thus suggesting a line of fit with a negative slope. Finally, a scatterplot with no real linear trend at all (i.e., $r = 0$) would have a line of fit that is horizontal, which means slope of 0. Whether positive, negative, or zero, the sign of the correlation r is the same as the sign of the slope of the line.

Here are lyrics to a song (sung to the tune of the familiar folk tune “Twinkle, Twinkle Little Star” that helped you learn the alphabet) to help you rehearse and permanently acquire this fact in your mind:

Correlation Song (lyric © 2013 Lawrence M. Lesser)

Are points near a line, or far?

What’s the correlation, r ?

If the fit supports a line,

Its slope and r would share the sign.

Twinkle, twinkle, you’re a star:

Knowing stats will take you far!

Click on this MP3 file

<http://www.causeweb.org/resources/fun/db.php?id=487>

so you can hear this 20-second jingle.

Now play it one more time (and sing along!).

Project UPLIFT: three urban settings

	Two-Year College	University (medium-size)	University (large)
Region of U.S.	Southeast	Southwest	Midwest
Student population	mostly Black	mostly Hispanic	general U.S. demographic
Type of course	Statistical literacy	Statistical literacy	Statistical literacy
Main audience	General education	Pre-service teachers	Arts and humanities
Text	Sullivan's <i>Fundamentals of Statistics: Informed Decisions Using Data</i>	Utts' <i>Seeing Through Statistics</i>	Moore & Notz's <i>Statistics: Concepts & Controversies</i>
Learning management system	Desire2Learn	Blackboard	Desire2Learn

student-randomized experiment (fall 2013)

(53 from comm. college; 194 from medium-sized university)

- All students asked to take pre-tests:

SATS (Survey of Attitudes Toward Statistics), **SAM** (Statistics Anxiety Measure)

- Half of the students randomized to have “fun inserts” in content readings accessed via LMS
- All students take midterms/finals with embedded multiple-choice items related to the (12-14) content readings
- All students asked to take post SATS & SAM

% Correct with and without Song Inserts

Topic	Without song	With Song	Difference
Margin of error: down with n down by $\sqrt{n}$	57.3% 9.1%	61.3% 10.0%	4.0% 0.9%
Standard score	62.5%	75.0%	12.5%
Correlation & slope	60.2%	73.8%	13.6%
Equiprobability bias	40.9%	50.0%	9.1%
Multiplicity	36.1%	37.0%	0.9% (medium university)
<i>p</i> -value	44.4%	50.0%	5.6% (2-yr. college)
OVERALL	42.3%	50.0%	7.7%
80% CI on total difference (2.8%, 12.6%) <i>p</i> -value ≈ 0.04			

Why did some fun items appear more effective than others?

Spearman's Rank Correlation of “Effectiveness” with “Activeness”

from two independent raters:
0.61 and 0.66