2018 NCTM Annual Meeting and Exposition

Full STEAM Ahead:

Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs

Larry Lesser (The **U**niversity of **T**exas at **E**l **P**aso)

joint work with Dennis Pearl (Pennsylvania State University), John Weber (Perimeter College at Georgia State University), and Dominic Dousa & Steve Haddad (UTEP)

Lesser@utep.edu

http://www.math.utep.edu/Faculty/lesser/Fun.html

(or you can Google my “Mathemusician” page)

supported in part by NSF grant **Project** Smiles

Student-**M**ade **I**nteractive **L**earning with **E**ducational **S**ongs (for introductory statistics)

PSU (1544426); UTEP (1544237); GPC (1544243)

smiles@causeweb.org

the math of UTEP’s Bhutanese architecture was in Sept. 2008 *Mathematics Teacher*!

quickly, 2 slides we won't discuss (but feel free to photograph)

….so we keep focus on (interactive statistics) SONGS

MATH	MUSIC
Ordinal numbers	naming intervals (e.g., fifths)
Geometric shapes	instrument shapes (e.g., triangle)
Geometric transformations	melodic transformations
Least common multiple	rhythm patterns; harmony (from pitches w/ low LCM)
Fractions	time signature; interval is a ratio of frequencies
Arithmetic sequence	overtones (f, 2f, 3f, 4f, …)
Geometric sequence	chromatic scale (in equal temperament)
Graph (pitch over time)	musical notes on a staff
Sine function	graph of (pure tone) sound wave
Permutations, Probability	“change ringing” of bells; Mozart’s “Musical dice game” (1793)
Statistics	DATA→SOUND: sonification SOUND→DATA: traits of hit songs
Group theory, modular arithmetic	analyze the set of pitches in a scale
Fourier series, partial differential equations	musical sound, acoustics

math in lyrics of "regular songs"…

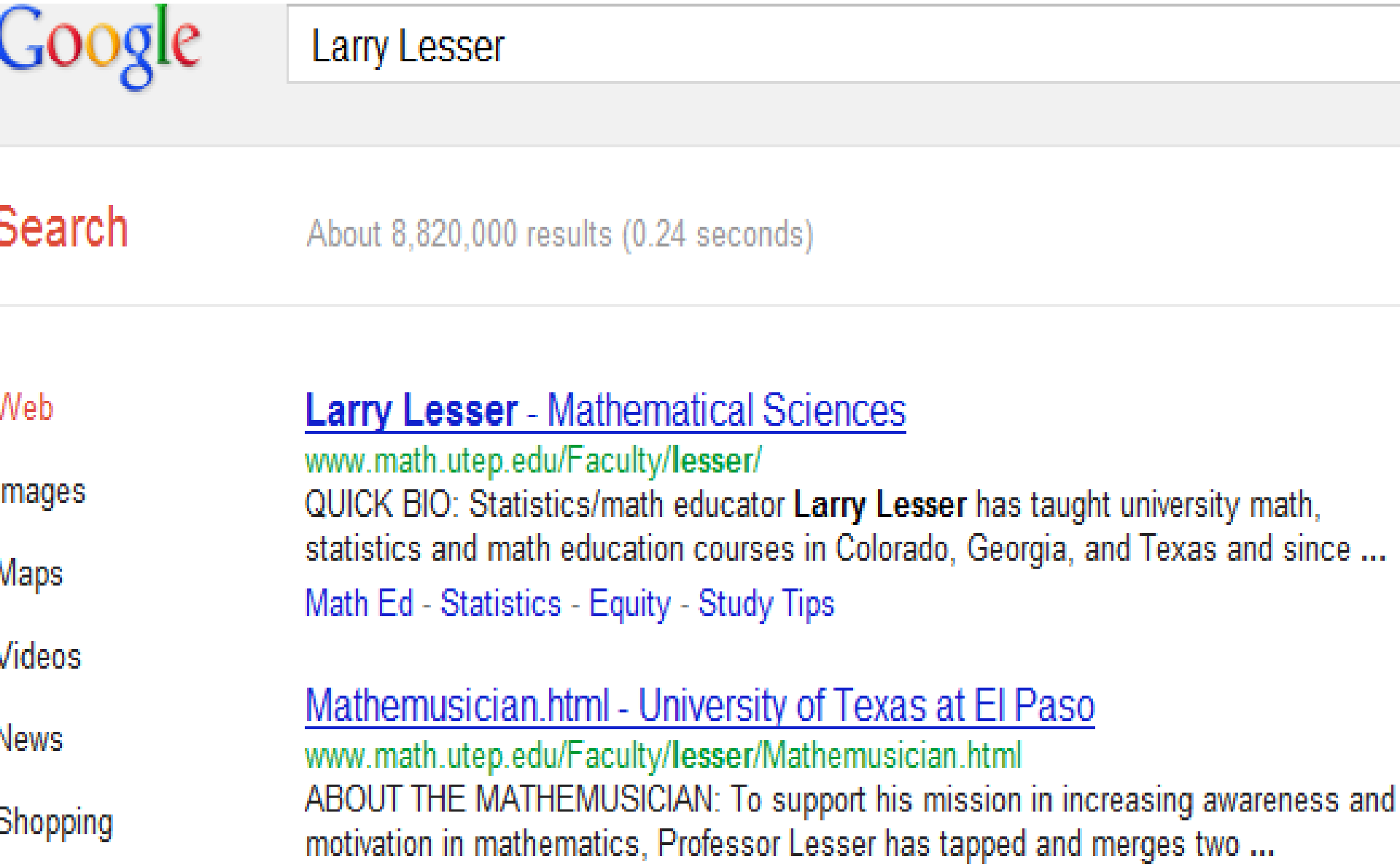
(from Lesser 2000, 2001, 2014)

- "One is the loneliest number" – Three Dog Night
- "if I could count infinity" – Christine Kane
- "100% chance of rain" – Gary Morris
- "reduce me to the mean" – Richard Shindell
- "random sample, hold the one you need" – Rush
- "at the edges of the bell-shaped curve" – David Wilcox
- "it's like a Möbius strip" – Nelly Furtado

OR concept without terminology: *regression to the mean* in Christine Lavin's "Attractive Stupid People"

know others? email me!

for more math & music (resources, lyrics, MP3s, etc.), than there's time to share today, just *Google* me!



OUTLINE

- *Background*
- Inspirations
  & Guiding Criteria
- Songs from the Collection
- Lessons Learned from Field Trials
- Tips for Use
- Q&A

67 TLC

Full STEAM Ahead: Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs!

General Interest Session

NSF, NEA, and Kennedy Center projects have used STEAM to reach diverse students. Our NSF-funded Project SMILES created 22 "interactive songs" for teaching intro statistics, and our approach applies also to other STEM courses. We share our guiding criteria, discuss field trials on engagement and effectiveness for learning, and discuss tips for use.

Lawrence Lesser
The University of Texas at El Paso
Dennis Pearl
Columbus, Ohio
John Weber
Perimeter College at Georgia State University, Clarkston

Walter E. Washington Convention Center, 154 AB

BACKGROUND

- *Finding statistics songs*
- Roles of song
- Motivations & hesitations
- About me

How to find STATISTICS songs

without a big search of YouTube or individual people's pages, etc.?

www.math.utep.edu/Faculty/lesser/Mathemusician.html

Resources & Bibliography	SONGS!	Cool Math & Music Quotes
More on Lesser	Presentations & Press	Contact Info

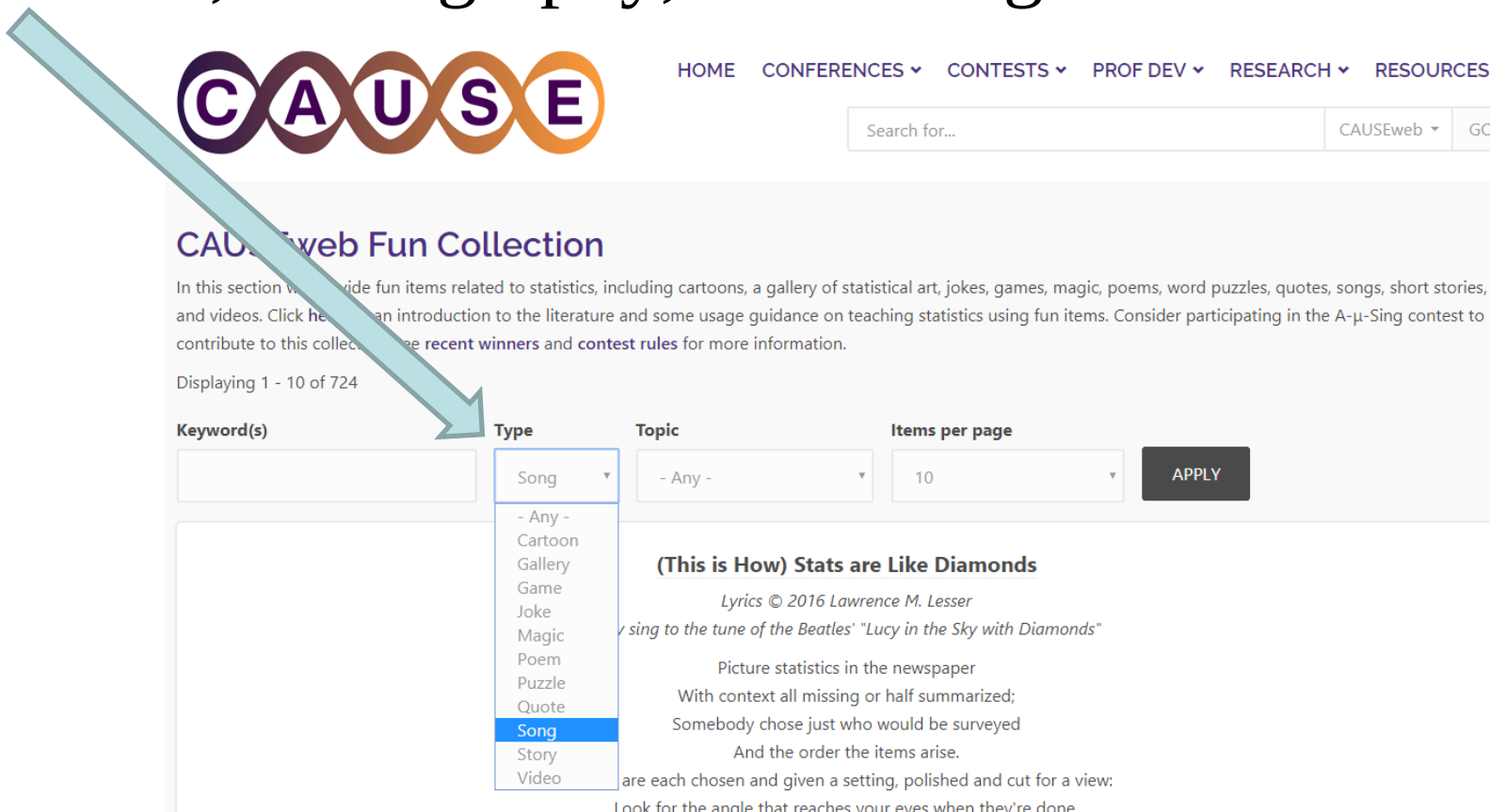
The MatheMusician

"Find, find the value of pi -- starts 3 point 1 4 1 5 9.
A good ol' fraction you may hope to define, but the decimal never dies ...."
-- from Larry Lesser's award-winning "American Pi"

ABOUT THE *MATHEMUSICIAN*: To support his mission to motivate learning mathematics/statistics, Professor Lesser integrates two great loves – math and music! An award-winning songwriter in general songwriting contests, Lesser has also won awards for educational songs and song videos in recent national contests (ASA, National Museum of Mathematics, CAUSE, QL-SIGMAA) and a video of songs was shown at Bridges 2014. His songs have yielded statistically significant learning gains in an NSF-funded randomized experiment, helped

causeweb.org

- site launched in 2005 (part of NSF's National Science Digital Library)
- Its curated, searchable 724-item fun collection includes 145 songs (almost all with soundfiles), 10 modalities, bibliography, & lesson guidance



fun fact: 1/4 of CAUSEweb songs are from a Texas HS teacher!

Mrs. Mary McLellan

My name is **Mary McLellan** and I teach AP Statistics. I absolutely love teaching AP Statistics because I feel as though it is extremely applicable to almost every aspect of life and certainly almost every career choice. I am passionate about teaching my students the fundamental concepts and the language of the world of Statistics.

I am a graduate of Texas Christian University with a Bachelor of Science in Mathematics as well as a Bachelor of Music in Piano Pedagogy. While I do not currently have a career that actively utilizes my music degree, I enjoy incorporating a musical component into my classes. I have fun creating songs to help my students remember and understand much of the vocabulary and concepts of statistics.

Phone: 817-441-8711

Email: mmclellan@aledoisd.org

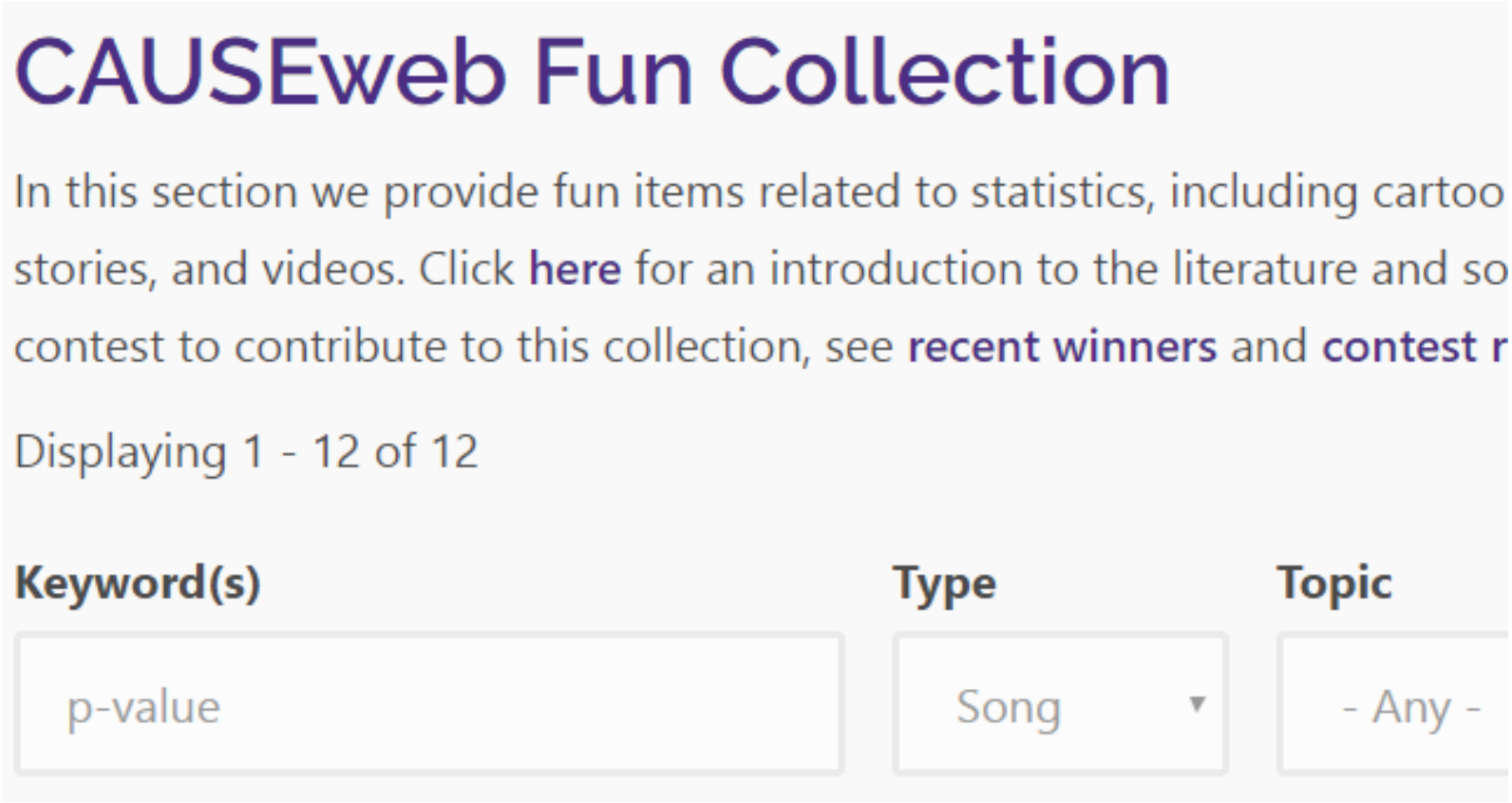
Degrees and Certifications:

Degrees:
Bachelor of Science in Mathematics

Subjects Taught: AP Statistics, grades 10-12

Math Bridge, grades 10-12

Example: if you're teaching *p*-value



…and you choose this…

What P-Value Means

Lyric ©2005 Lawrence Mark Lesser;
May sing to tune of "Row, Row, Row Your Boat"

It is key to know
What p-value means --

It's the chance
(with the null)
you obtain
data that's

At least that extreme!

0:00 / 0:12

Download

Rating:

Average: 5 (1 vote)

…which has lesson guidance

Description (From the full CAUSEweb record description at: https://www.causeweb.org/cwis/r1248/song_what_p-value_means): Song is simply a quick jingle to help students recall the conceptual interpretation of a p-value. May be sung to tune of "Row, Row, Row Your Boat". Recorded June 26, 2009 at the OSU Whisper Room: Larry Lesser, vocals/guitar; Justin Slauson, engineer.

URL for lyric and soundfile: http://www.causeweb.org/resources/fun/db.php?id=86

Length of song: 10 seconds

Goal: helping students learn (and practice saying) the interpretation of a p-value

Target audience: students in any class that introduces p-values

Set-up: discuss a real-life vignette's probability such as "in a 10-child family, 9 babies were girls". Discuss what would be even more "extreme" (10 of 10 girls; if two-tailed, 9 or 10 boys as well) and unpack that there is an implicit null hypothesis that the probability of a birth being a girl is about 0.50, and that the 7 of 7 feels unusual because under the null hypothesis of independent births with P(girl) = 0.5 each time, it seems very unlikely to get 9 or more of the babies to be girls. Play the song.

In-class Use: Play the soundfile (http://www.causeweb.org/resources/fun/db.php?id=86) so students can hear the song (and read the lyric at the same time, making sure you select an updated browser that allows this). Then play it again and have the class sing along. For more adventurous classes, try singing it in a two-part round as "Row, Row, Row Your Boat" would be (i.e. after one half of the room finishes "It is key to know," the other half begins the song as done in the video at www.youtube.com/watch?v=CJrXuooX7hI.

Online self-paced use: instruct students to do a "set-up" reading, then click on the soundfile to play the song several times, then click on the "follow-up" reading

Follow-up: recap the pieces of the song to make sure students understand what is meant by "extreme" (try a different scenario to assess this and move away from the p=0.5 null hypothesis: a basketball player makes 7 of 10 free throws) and give examples that are one-tailed and examples that are two-tailed. Emphasize the conditional (i.e., "if the null hypothesis is true, then the probability of....") structure of the interpretation of a p-value.

Assessment: on the next midterm or quiz, try a relevant CAOS-pool item from the ARTIST database (https://apps3.cehd.umn.edu/artist/ or https://apps3.cehd.umn.edu/artist/tests/index.html); or here's a multiple-choice item adapted from Vogt, 2007 p. 13:

A p-value of .03 means:

1. There's a 3% chance the null hypothesis is wrong.
2. The probability that the result is due to chance (is a coincidence) is 3%.
3. A result of this size would occur by chance alone 3% of the time.
4. If the null hypothesis were true, the probability of getting a result at least this far away from the null hypothesis would be 3%.

songs often written/discovered via national contests!

MOMATH
NATIONAL MUSEUM OF MATHEMATICS

What's happening at the Museum.

Registration is closed for this event

***Open Set* 2018 - MoMath's Song Contest**

Make math your muse! MoMath is now accepting submissions for its annual mathematical song competition, *Open Set*. Write your own words to a favorite tune or compose your own melody; the only rules are that the lyrics must be original and must be about math or a mathematical concept. The winners will be announced and will have a chance to perform their winning songs at an open mic night at MoMath this spring.

To submit a song, you will need:

- A title for your song
- Original song lyrics (the melody can be original or based on an existing song)
- A video or audio file of yourself performing the song, uploaded to YouTube. For instructions on uploading a private YouTube video, click **here**.

Apply today! Applications will be accepted through **April 1, 2018**.

You can view last year's performances at **openset2017.momath.org**.

causeweb.org/cause/a-mu-sing/2018/rules

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CAUSE

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A-mu-sing

Caption Contest

USPROC

2018 A-μ-Sing Competition Rules

1. Any (high school, undergraduate, or graduate) student of statistics is eligible to enter. Each entry must have content that is relevant to statistics or statistics education. By entering, entrants warrant that the items have not already been published (possible exception: a local newsletter or entrant's homepage) or submitted for publication, including to the collection at www.causeweb.org/cause/resources/fun.
2. Entries must be received by **April 1, 2018**. Entries should be submitted electronically if possible

considerations

- Align with learning objectives and standards (CCSSM, PSSM, GAISE, etc.)
- Setup or pre-assessment
- Delivery: in class (a capella, live instrument, karaoke, or MP3) or offline
- Student level of participation
- Pre/post exploration or assessment

BACKGROUND

- Finding statistics songs
- *Roles of song*
- Motivations & hesitations
- About me

song helps recall

(which can free up resources for higher order thinking):

- "The Alphabet Song" to learn ABCs
- Ray Charles' "Fifty Nifty United States" to learn 50 U.S. states (in alphabetical order!)
- about 60 Schoolhouse Rock (on ABC) songs spanned Multiplication (by 2,…,12), Grammar (e.g., "Conjunction Junction"), America, Science, Money, Earth
- Quadratic formula has been sung as:

Pop Goes the Weasel, Frère Jacques, Battle Hymn of the Republic, Amazing Grace, Macarena, Jingle Bells, Over the Rainbow, Gilligan's Island, etc.

SONG vs. PROSE:

It is key to know
what *p*-value means –

It's the chance
(with the null)
you obtain
data that's
at least that extreme!

A *p*-value is the probability you obtain
at least this strong of a difference
if the null hypothesis of no effect
were really true.

but song can also go *beyond* recall

(Lesser, 2014)

- introduce concepts/terms
- reinforce thinking process
- connect to history/real-world
- humanize

BACKGROUND

- Finding statistics songs
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- About me

Motivations

Multidisciplinary connections,

Memory aid,

Multiple intelligences,

Motivation,

Making community,

Math anxiety reduction,

Mashing stereotypes (content, class, teacher),

Modelling stretching, etc.

Hesitations	Solutions
Can't quickly find good examples	CAUSEweb.org, singaboutscience.org, etc.
No skills/talent	Press "PLAY"; tap student talent
Uses too much time	Streamline length. Use as students enter or papers handed back or have students access online outside class.
Clash with students' cultures	Know your audience (week 1 survey, etc.)
Need to be seen as serious by students	Make connections to content (or assessment); make a mini-lesson plan
Need to be seen as serious by colleagues/supervisor; Unaware of evidence of helping learning	See studies and statements supporting engaging/active learning
Copyright permission	Apply "fair use test" as with other materials

Lesser et al. (2013)

(first?) stat song classroom study

(VanVoorhis, 2002)

2 equal-GPA sections of stats

Section R **r**ead 3 definitions aloud;

Section S **s**ang 3 stat jingles (for same concepts)

S did better than R on relevant test items

***p* < .05**

S had high correlation between test score and self-rated jingle knowledge

***p* < .05**

BACKGROUND

- Finding statistics songs
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- *About me*

my early trajectory

- 1983: became songwriter and math major
- 1992: released cassette(!) of “regular songs”, yielding 1st airplay, reviews, awards, etc.;

then tried music in my math teaching

it’s led to articles….

(remember, links are on
my Mathemusician page)

first comprehensive papers on song in math (May 2000 *MT*) & statistics (Autumn 2001 *TS*) class

Sum of Songs:
Making Mathematics Less Monotone!

TEACHING **STATISTICS**
An International Journal for Teachers

Musical Means: Using Songs in Teaching Statistics

KEYWORDS:
Teaching;
Lyrics;
Songs;
Hypothesis test;
Permutations;
Mozart effect.

Lawrence M. Lesser
Armstrong Atlantic State University, Georgia, USA.
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Summary
Songs offer fresh motivations for probability and statistics.

2013 article in *European J. of Science and Math. Education* connects math to guitars

- How frequency varies with a string's length, tension, mass
- How frequency ratios sound
- Location patterns of guitar harmonics and frets

Scientific skateboarding and mathematical music: edutainment that actively engages middle school students

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Abstract: Edutainment has recently been a major growing area of education, showing great promise to motivate students with relevant activities. The authors are among innovators who have developed cutting-edge fusions of popular culture and STEM concepts to engage and to motivate middle school students, using vehicles such as music/song and skateboarding. The importance of using relevant and practical methods of instruction and curriculum delivery that build on student interests and increase enjoyment in the learning process are critical at the middle school level, especially in the STEM fields. The use of edutainment in this manner is meant to inspire broader interest in mathematics and science for middle school students and to develop a culture of education that makes learning more accessible to all students. This paper surveys and illustrates the use of such immersive modalities to involve middle school students actively with concepts and suggests further directions for the use of demonstrations and videos in educational settings.

Keywords: action, science, mathematics, skateboarding, music.

2014 paper on using & writing math lyrics

Journal of Mathematics and the Arts, 2014
Vol. 8, Nos. 1–2, 46–53, http://dx.doi.org/10.1080/17513472.2014.950833

Mathematical lyrics: noteworthy endeavours in education

Lawrence M. Lesser*

Department of Mathematical Sciences, The University of Texas at El Paso, El Paso, TX, USA

(*Received 26 January 2014; accepted 29 July 2014*)

Mathematical lyrics are song lyrics connected to, or inspired by, mathematics or statistics. This paper explores various types of mathematical lyrics and their roles in mathematics education. In particular, the paper contains many examples of my own lyrics as well as an extensive bibliography of lyrics composed by others. It also provides resources and strategies for creating such lyrics and for using them in an educational setting.

Keywords: mathematical lyrics; statistical lyrics; song; songwriting; mathematical pedagogy

AMS Subject Classifications: 00A65, 97D40, 97F90, 97A99, 97M80, 97C99

1. Introduction

Popular among students of all ages, songs with lyrics can be a valuable vehicle for learning and engagement. Many early examples of the use of mathematical lyrics in edu-

such as Tom Lehrer [63], Klein Four Group [29], Steve Sodergren [55], The Fifth Moment [1], Marc Gutman [22], Dane Camp [6] and a math parody band aptly named the Derivatives [4]. While songs can build community at

2015 *J. of Mathematics Education* paper illustrated creation/use of a song

Journal of Mathematics Education
December 2015, Vol. 8, No. 2, pp. 158-168

"American Pi": The Story of a Song about Pi

Lawrence M. Lesser
The University of Texas at El Paso, USA

This paper begins by overviewing motivations and means for using music in the teaching of mathematics – in particular, six roles for the use of song. We then share inspirations and variations for the award-winning song "American Pi" (which parodies a song that topped the charts in the United States, Australia, Canada, and New Zealand), followed by overviewing several options for implementation in the mathematics classroom, especially the high school classroom. It is hoped that focusing on characteristics and trajectory of one particular mathematics song may help yield a framework or context for examining, using, and writing other mathematics songs.

Key words: Pi, lyric, song, humanistic mathematics, mathematics history.

Motivations

There are many ways music can be used to motivate or facilitate the learning of mathematics. Robertson and Lesser (2013) include many references

March 12-18, 2016 feature (during Music in the Schools Month) for ES students

The Mini Page®
Issue 11, 2016
Founded by Betty Debnam

Next Week: Giant panda update

Music = Math!

Mini Quote:

"Music is the pleasure that the human soul experiences from counting without being aware that it is counting."
—German mathematician Gottfried Wilhelm von Leibniz

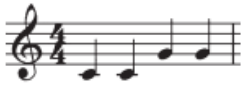
March is Music in Our Schools Month, but we don't have to limit music to just one month or to music class. Most concepts in music make *note*worthy connections to math!

Rhythm and arithmetic

You have sung many songs without realizing you are counting beats with a certain pattern. For example, clap along while you sing "Rock-a-Bye Baby." Notice how the syllables of the lullaby naturally suggest counts of 1-2-3 as you sing it, even though some syllables get more than one beat.

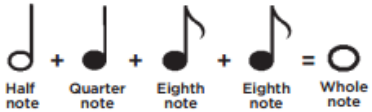
Fractions in music

We say "Rock-a-Bye Baby" is in "three-quarter time" because each **measure,** marked off by vertical lines in the sheet music, contains the equivalent of three quarter notes. (The **time signature** visually resembles the fraction 3/4.) Other songs have different rhythmic patterns. For example, a popular song in "four-four time" (where each measure gets the equivalent of four quarter notes) is "Twinkle, Twinkle Little Star."



Notes can be **whole** notes, or **half, quarter, eighth, 16th, 32nd** or **64th** notes. In 4/4 time, a whole note gets four beats.

Using fraction math, you can see that 1/2 + 1/4 + 1/8 + 1/8 = 1, just as four quarter notes would also add up to 1. Can you think of other fractions that would add up to 1?



Harmony and fractions

Borrow a guitar from a teacher or friend. The length of a guitar string affects the pitch of the note the string makes.

Choose one of the strings and pluck it, then play that same string while holding it down against the fretboard so that only half of the string's length is free to vibrate. You notice not only the mathematical relationship that shortened strings have a higher pitch, but the two notes also sound the same, yet different.

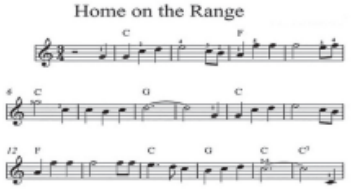
Harmony involves fractions. The string lengths are in a 2-to-1 ratio, and the shorter length vibrates twice as much as the longer length. This produces the sound of an octave.

What other words does **octave** remind you of? Octagon? Octopus? If you write out the major scale (do, re, mi, fa, so, la, ti, do), the "low do" and "high do" span eight notes. (Play the white piano keys from C to the next highest C, for example.)

The low C and the high C are the same note, but different octaves.

Graphing music

We can see that sheet music notation is really just a graph. Written music graphs two variables: the length of time (duration) of each note, and the pitch (frequency) of that note.



Math songs

Not only is there math in music, but you can also bring music to math by singing (or writing!) songs about math.

The National Museum of Mathematics has held contests for math teachers and students to write math songs. Try taking a song you know and changing the words or adding onto it to illustrate whatever math concepts you are now learning in school.

Resources

On the Web:
- bit.ly/1nE0pbm
- bit.ly/1RYFEUO
- momath.org

At the library:
- "Music Math: Exploring Different Interpretations of Fractions" by Kathleen Collins

latest work…

- Archived presentation for VOICES 2017: https://www.causeweb.org/voices/2017/panel/1-3
- “early view” 2018 paper in *Teaching Statistics*
- May 14, 2018 videoposter for showcase: http://stemforall2018.videohall.com/
- May 2018 workshop & videoposter at eCOTS
- July 2018 paper at ICOTS

it’s gone beyond articles….

- Media coverage
- Awards
- Keynotes

Australia's largest newspaper ([Melbourne] Herald Sun, 3/31/2002)

2016 interview in top STEM songwriting blog

STEM songster interview #19: Professor Lesser

Posted on February 18, 2016 by crowther

November 2015: Larry Lesser prepares to play "The Gambler," one of his winning entries in the 2015 Museum of Mathematics (MoMath) song contest.

One of the only people in this world who devotes as much time as me, or more, to writing educational STEM songs and thinking about how to use them effectively is Prof. Lawrence M. Lesser of The University of Texas at El Paso (UTEP). After years of occasionally corresponding with Larry via email, and reading his papers, I was excited to meet him in person for the first time when he recently visited Seattle — a visit which led to the following interview.

Sing About Science & Math: *This interview, conducted via email, is an extension of a conversation we began in Seattle. Larry,*

Sound way to learn maths

A teacher puts complex maths theories to music — and SAMANTHA AMJADALI finds it adds up

Larry Lesser has discovered the secret to fostering a love for mathematics in his students — Kenny Rogers' catchy ballad *The Gambler*.

Dr Lesser, a mathematician with a penchant for song, found his charges couldn't grasp the bamboozling theories in his university courses. So he simply put the complex formulae and equations, to music. Now students flock to his classes — and they're getting better marks.

His students learn to memorise the value of Pi to the tune of Don McLean's *American Pie*, they're taught the features of a graph to Bette Midler's *From A Distance* and, for those interested in the mathematics of random occurrences such as lotteries it's *The Gambler* which they gleefully sing along to.

Dr Lesser said his two-minute maths ditties were generally the only thing a student would recall from a lesson — sometimes the entire semester's course.

"Although music does help with memorisation, I use it more for motivation," said Lesser, a maths professor at Armstrong Atlantic State University in Savannah, Georgia.

"They're certainly outstanding mnemonic devices to help students learn and recall information, often with more enjoyment or less anxiety."

Dr Lesser chooses rap songs for memorising basic facts, but prefers longer, catchier tunes such as *We Will Graph You*, a reworking of Queen's classic *We Will Rock You*, (lead singer Freddie Mercury is pictured above) for learning fundamental theories such as the procedures needed for graphing a line or parabola.

But Dr Lesser won't whack his precious words into any old song. He chooses his songs lovingly and avoids profane songs and sacred tunes, preferring instead to use chart toppers that his generally teenage students will know.

www.math.armstrong.edu/faculty/lesser/Mathemusician.html

The method

Freddie Mercury's algo-rhythmic vocals have been "re-purposed" by Larry Lesser, who teaches students to graph a given function using the tune of Mercury's *We Will Rock You*.

The students must chant and clap the song in unison.

Lesser's bizarrely effective rendition is called *We Will Graph You* and goes like this:

You wanna draw a parabola
from the general form algebra.
Don't despair, complete the
square. The x of the vertex comes
out there, and we will, we will
graph you! (chorus twice re-
peated).
The vertex now is figured out,
but does the graph smile or
frown?
The number next to the square
of x, gave the sign to make the
sketch, now — we will, we will
graph you! (twice repeated).
Find and plot any x-intercepts,
the constant c is the y-intercept.
A vertical line through the
vertex, gives symmetry for your
sketch, and we have, we have
graphed you! (twice repeated).

coverage of contest wins

held by the Consortium for the Advancement of Undergraduate Statistics Education, National Museum of Mathematics, etc.

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Math Song Wins on Pi Day of the Century

Last Updated on March 16, 2015 at 10:20 am

EL PASO, Texas – Director of the Center for Excellence in Teaching and Learning at The University of Texas at El Paso Larry Lesser, Ph.D., is now a national award-winning songwriter.

In honor of the Pi Day of the Century, since the date March 14, 2015 (3/14/15), is the only date in the 21st century that contains the first five digits of the number pi (3.1415), the Museum of Mathematics in New York City sponsored a related worldwide song contest.

The nation's only math museum attracted more than 100 entries. Lesser entered two pi-themed songs, "American Pi" (a parody of Don McLean's No. 1 hit "American Pie") and "Pi Will Go On" (a parody of the Celine Dion hit "My Heart Will Go On" from the movie *Titanic*). "American Pi" was announced as the winner at 3:14 p.m. ET on Pi Day, March 14, at the museum.

elpasotimes.com

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UTEP professor wins Pi Day of the Century songwriting contest

By Aaron Martinez / El Paso Times

POSTED: 03/14/2015 05:26:19 PM MDT

Listen to Greatest Lesser Hits

It will only happen once this century and for a math professor at the University of Texas at El Paso, Pi Day 2015 will be a day he will never forget.

Out of more than 100 entries from across the globe, UTEP Mathematical Sciences Department Professor Larry Lesser's was declared the winner of the Museum of Mathematics' Pi Day of the Century songwriting contest on Saturday.

"It was a really hoot to win this contest, " said Lesser, who is director of the Center for Excellence in Teaching and Learning. "It was just shocking and such a great honor to win a national, well,

conference edutainment

- for mathematicians (e.g., MAA MathFest opening banquet)
- for statisticians (e.g., USCOTS banquet)
- for K-12 teachers (e.g., opening session of NCTM Regional in Nashville)

7:00 p.m.–8:00 p.m.

1

Composing Connections: Mathemusician Merges Math and Music in the Music City!

(General Interest) Session

A mathematics education professor, former schoolteacher, and published songwriter will share inspiring, diverse, and accessible connections between math and music that can help increase studens't motivation and appreciation for math. His engaging math songs and raps have appeared in many journals and had international mass media coverage.

Lawrence M. Lesser
University of Texas at El Paso, El Paso, Texas

205 (Convention Center)

And yet….

….my most challenging and fun math/stat songwriting was yet to come….

OUTLINE

- Background
- *Inspirations*
  & Guiding Criteria
- Songs from the Collection
- Lessons Learned from Field Trials
- Tips for Use
- Q&A

67 TLC

Full STEAM Ahead: Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs!

General Interest Session

NSF, NEA, and Kennedy Center projects have used STEAM to reach diverse students. Our NSF-funded Project SMILES created 22 "interactive songs" for teaching intro statistics, and our approach applies also to other STEM courses. We share our guiding criteria, discuss field trials on engagement and effectiveness for learning, and discuss tips for use.

Lawrence Lesser
The University of Texas at El Paso
Dennis Pearl
Columbus, Ohio
John Weber
Perimeter College at Georgia State University, Clarkston

Walter E. Washington Convention Center, 154 AB

randomized experiment (July 2016 *JSE*)

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http://dx.doi.org/10.1080/10691898.2016.1190190

Assessing Fun Items' Effectiveness in Increasing Learning of College Introductory Statistics Students: Results of a Randomized Experiment

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ABSTRACT

There has been a recent emergence of scholarship on the use of fun in the college statistics classroom, with at least 20 modalities identified. While there have been randomized experiments that suggest that fun can enhance student achievement or attitudes in statistics, these studies have generally been limited to one particular fun modality or have not been limited to the discipline of statistics. To address the efficacy of fun items in teaching statistics, a student-randomized experiment was designed to assess how specific items of fun may cause changes in statistical anxiety and learning statistics content. This experiment was conducted at two institutions of higher education with different and diverse student populations. Findings include a significant increase in correct responses to questions among students who were assigned online content with a song insert compared with those assigned content alone.

KEY WORDS

CAUSEweb fun collection; Humor; Song; Statistics education research

diverse settings/populations for a statistical literacy course

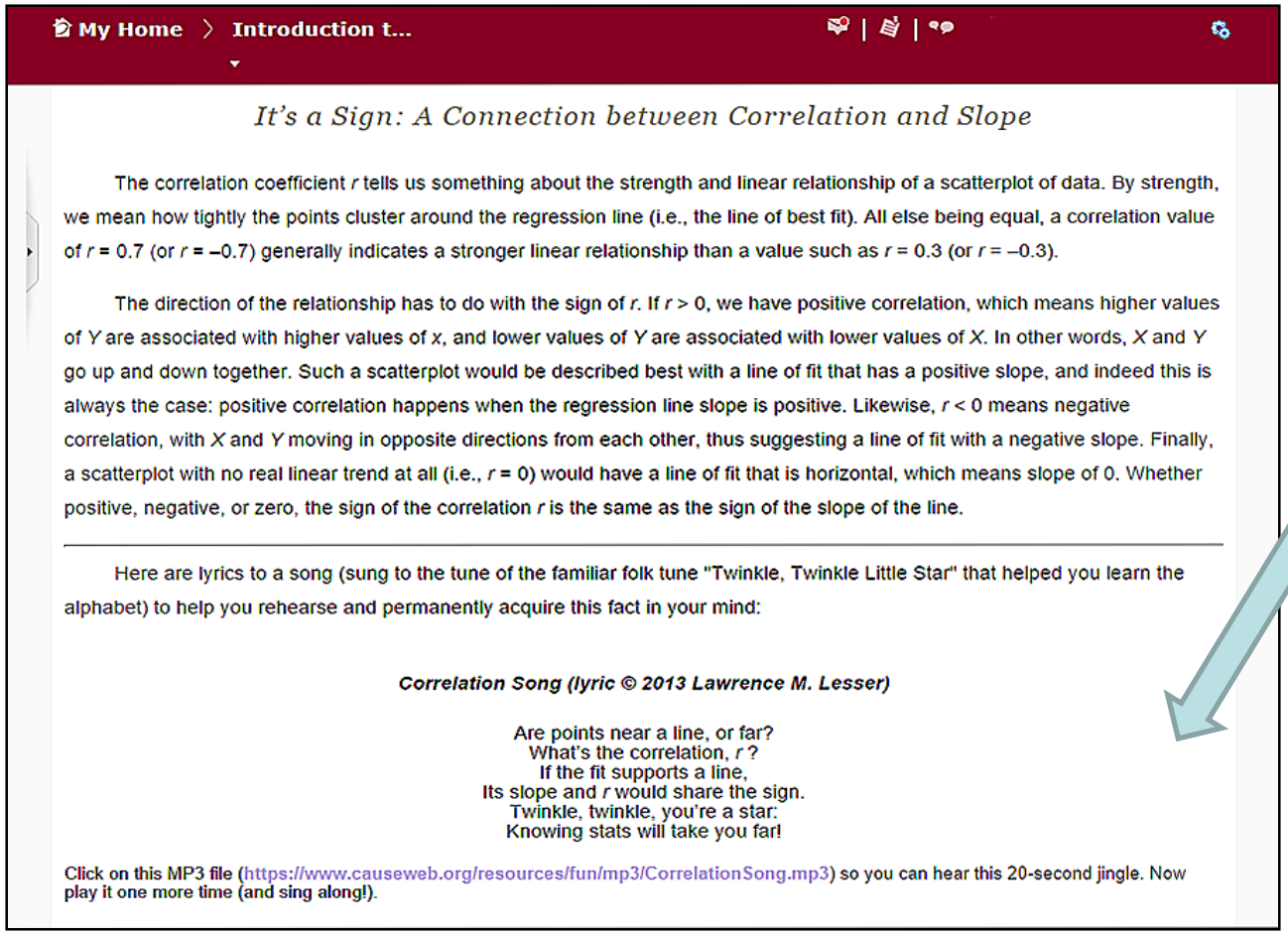
	Two-Year College	University (medium-size)
Region of U.S.	Southeast	Southwest
Student population	mostly Black	mostly Hispanic
Sample size (*n*)	53	194
Main audience	General education	Pre-service teachers
Text	Sullivan (2014) *Fundamentals of Statistics: Informed Decisions Using Data*	Utts (2005) *Seeing Through Statistics*
LMS (Learning Management System)	Desire2Learn	Blackboard

student-randomized experiment

- All students told their exams would have (12-14) embedded (MC) items related to online (LMS) content readings.

- Half the students randomized to always have "fun inserts" (song, cartoon, etc.) in those readings

mini-reading with insert



My Home > Introduction t...

It's a Sign: A Connection between Correlation and Slope

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 $r = 0.7$ (or $r = -0.7$) generally indicates a stronger linear relationship than a value such as $r = 0.3$ (or $r = -0.3$).

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 (https://www.causeweb.org/resources/fun/mp3/CorrelationSong.mp3) so you can hear this 20-second jingle. Now play it one more time (and sing along!).

% Correct without and with Song Inserts

Topic	Without song *n* = 88	With Song *n* = 80	Difference
Margin of error: down with n down by √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)
p-value	44.4%	50.0%	5.6% (2-yr. college)
OVERALL	**42.3%**	**50.0%**	**7.7%**
			2-tailed *p*-value ≈ 0.04

we wondered……

why did songs have significant difference

but not cartoons?

and if it's because songs are more interactive,

how could songs get still *more* interactive?

Note: **Active learning** is a principle for good practice in undergraduate education (Chickering & Gamson, 1987); active learning in STEM is supported by meta-analysis of 225 studies (Freeman et al., 2014)

One idea to make songs more interactive

(inspired by the work of Dane Camp
and by the ELL “sentence frame” tool)

students complete the rhymes in real time!

Example using "Correlation Song", the experiment's top-performing song

(using the tune that helped us all learn the alphabet)

Are points near a line, or far?
What's the correlation, ___?
If the fit supports a line,
Its slope and *r* would share the ___.
Twinkle, twinkle, you're a star:
Knowing stats will take you ___!

 Tune: "Twinkle, Twinkle Little Star"

LIMITATIONS of “complete the rhyme” approach

- Need simple rhyme scheme.
- Only one word can be the correct answer, which limits what can be assessed.
- May be too easy to fully engage students.
- May need a live whole-class setting for best results.

continuum of interactiveness of song
(see my 2017 VOICES talk:
https://www.causeweb.org/voices/2017/panel/1-3)

For example: having a student…

hear song <

provide inputs <

write song

Quick! Write down:

An exclamation

An adverb

A verb ending in ‘ing’

A plural noun

now read your “Mad Libs result”:

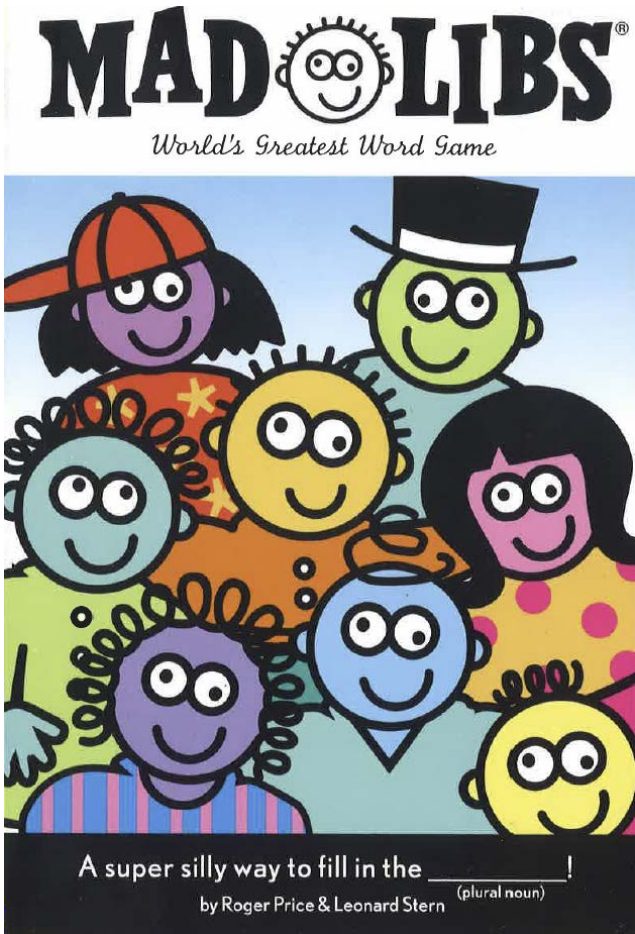
“_____!” **she said** _____. **This**
[exclamation] *[adverb]*

talk is like_____ _____!”
[verb ending in ‘ing’] *[plural noun]*

a Mad Libs approach…

has been adapted for educational use, including in teaching statistics (e.g., Trumpower, 2010)

A researcher uses a 2 *height (short, tall)* × 2 *relationship status (unmarried, married)* between-subjects, factorial design to study the effects on *maximum bench press ability* (as measured on a 10-point scale, with 10 indicating the greatest and 1 indicating the least *maximum bench press ability*). After collecting data, the researcher calculates the mean *maximum bench press ability* of participants in each condition of the study, as summarized in



2015 - present NSF EAGER grant (DUE 1544426, 1544237, 1544243)

Project Smiles

Student-**M**ade **I**nteractive **L**earning with **E**ducational **S**ongs (for introductory statistics)

Wrote (and assessing) two dozen *interactive* songs
of high aesthetic and pedagogical quality
to maximize learning and engagement;
collection to be released by May 14 at:

https://www.causeweb.org/smiles/

My fellow PIs: Dennis Pearl (Penn State) & John Weber (Georgia State)
see our VOICES2017 and STEMforAll2018 videoposters

Statistics: a great vehicle for the grant

- Statistics is offered in several departments and taken by students in many disciplines, and is also offered in HS

- Statistics anxiety occurs across disciplines (e.g., in the humanities, social sciences, and in classes for pre-service elementary school teachers), and anxiety-reduction is one potential benefit of the use of fun items

Let’s see what it’s like to *SMILE-ify* an existing CAUSEweb song….

What P-Value Means

Lyric ©2005 Lawrence Mark Lesser;
May sing to tune of "Row, Row, Row Your Boat"

It is key to know
What p-value means --

It's the chance
(with the null)
you obtain
data that's

At least that extreme!

Download

What P-Value Means

1. Calculating the p-value assumes the Select hypothesis is true.

   - null
   - alternative

2. Please answer **question 1** to reveal this q

3. Please answer **question 2** to reveal this question.

What P-Value Means

1. Calculating the p-value assumes the **null** hypothesis is true.

2. The p-value is a probability associated with the variation of the Select if the **null hypothesis** is true.

   - parameters
   - data
   - hypotheses

3. Please answer **question 2** to reveal this question.

What P-Value Means

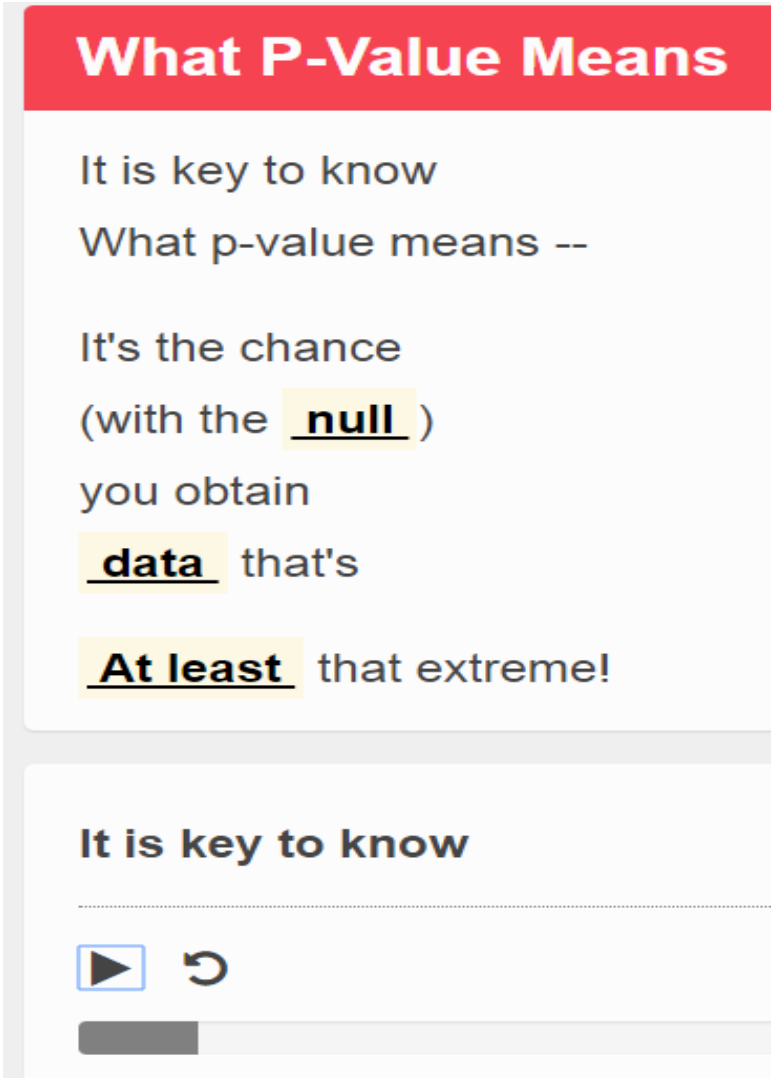
1. Calculating the p-value assumes the null hypothesis is true.

2. The p-value is a probability associated with the variation of the data if the **null hypothesis** is true.

3. The p-value is a probability associated with obtaining/observing a value Select as extreme as the value you got if the null hypothesis were true.

nue

CAUSE song SMILE-ified!



most CAUSEweb songs can't be retrofitted, due to:

- parodying a song that is unduly profane, sacred, or obscure or is copyrighted, and thus limiting usage
- not focused deeply on a single statistics learning objective, such as including statistical terms without conceptual grounding
- too lengthy
- content too advanced for intro course
- having, in constrained rhyming positions, important statistics examples unlikely to be supplied in response to open-ended prompts
- consists only of elaborated examples so that potential student inputs would need entire sentences rather than the concise bits of input needed in our situation
- limited only to lower-order thinking or recall
- interesting artistically or for community-building among insiders,

  but not useful for a novice learner

Inputs…

- must avoid end-rhyme spots

(though lyrics usually DO put key words there)

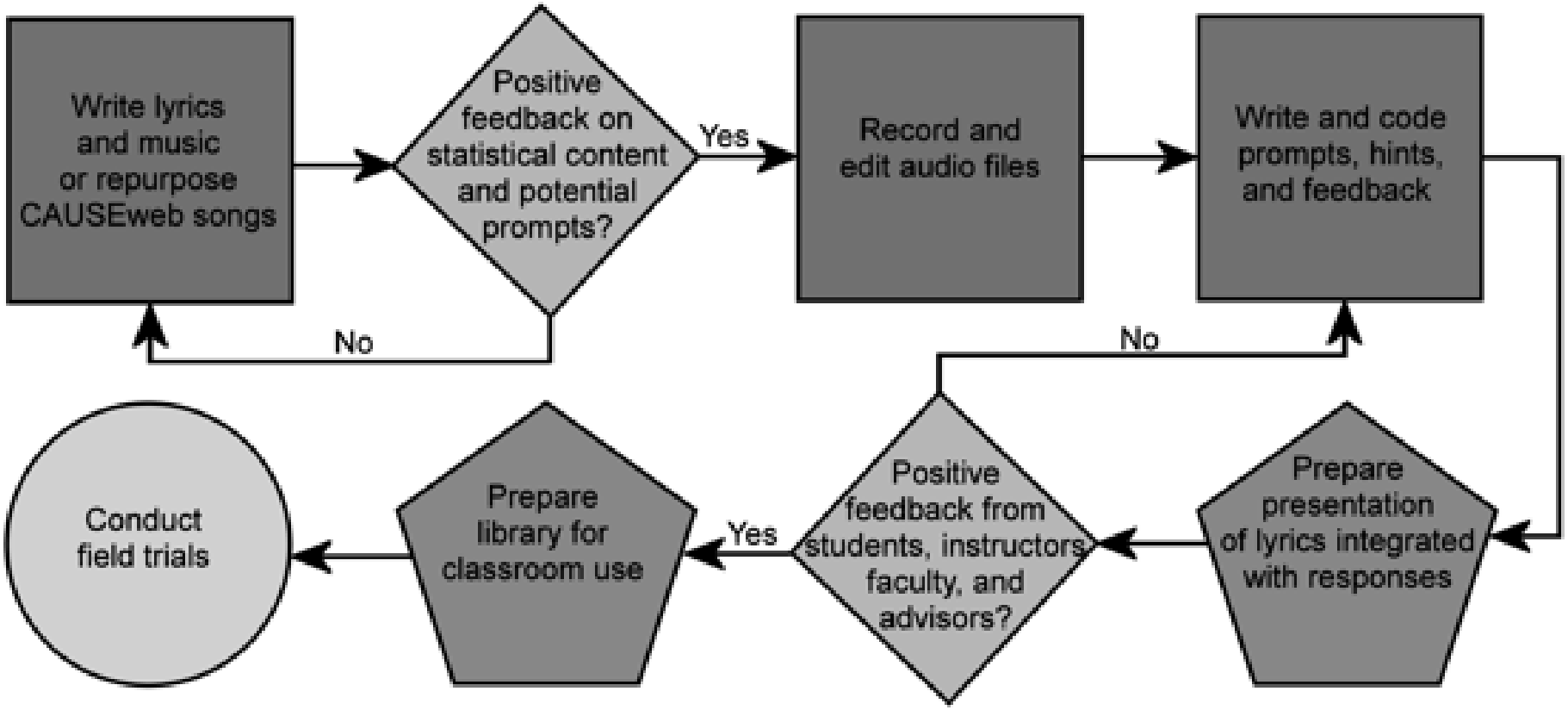
Correlation Illustration Song

How do **shoe length** values go
When **height** is high or when it's low?
Like horses on a merry-go-round
Where they're both up or they're both down,
This provides an illustration of a positive correlation!

How do **used car prices** go
When **mileage** is high or low?
Like horses on a merry-go-round
Where one is up when the other's down,
This provides an illustration of a negative correlation!

- must be scaffolded for part of speech, and robust for number of syllables, etc.

process


Write lyrics and music or repurpose CAUSEweb songs
Positive feedback on statistical content and potential prompts?
Yes
No
Record and edit audio files
Write and code prompts, hints, and feedback
No
Prepare presentation of lyrics integrated with responses
Positive feedback from students, instructors, faculty, and advisors?
Yes
Prepare library for classroom use
Conduct field trials

The SMILES Dream Team

songs written by external collaborative of music and STEM professionals… (*no small task to find them!)*

- **Greg Crowther** (Seattle, WA) – college biology lecturer, researches in science ed (STEM songs) and science, curates singaboutscience.org database of 7000+ songs
- **Monty Harper** (Stillwater, OK) – award-winning full-time performer/writer of educational science songs; MS in math
- **Tom Toce** (NYC) – theater/cabaret songwriter with album cuts and ASCAP awards; senior actuarial adviser at Ernst & Young; Fellow of Casualty Actuarial Society
- **Amy Adler** (Austin, TX) – songwriter, cantorial soloist, music teacher, CPA, Certified Fraud Examiner

…and internal (UTEP) collaborators

- **Larry Lesser** – stat ed researcher; award-winning songwriter; published 75+ math/stat lyrics and several papers on using music in statistics/math courses
- **Dominic Dousa** – music theory and composition faculty; (piano) accompanist and chamber musician; MS in statistics; college teaching experience in statistics

SMILES song criteria

- Short
- Built for inputs
- Connect to real-world data if possible
- Music: original or public domain
- Lyrics: help learning of an intro statistics learning objective
- Lyrics: had to be easy to hear
- Maximize intelligibility of the synthetic voice singing student inputs

for intelligibility of the synthetic voice singing student inputs:

- **DURATION**: to allow for the longest available response, we lengthened rhythm of some words where recorded sounds would be inserted and quickened the rhythm of words surrounding the insertion point.

- **PITCH**: we tried to avoid skips or even having more than one note in the insertion point to help the process of programming the pitch of the inserted material

and then, Steven Haddad

coordinates talented music majors in UTEP's Commercial Recording studio!

and then Bob Carey

integrates it into the website
with the Festival Speech Synthesis System/FestVox

Diversity factors/feedback

- Good to vary singer gender, genre, etc.
- Song affected by specific diversities of instructor and campus population; e.g., don't parody a hymn, "Yellow Rose of Texas", etc.
- Readings have gender diversity and avoid stereotypes (my April 2014 *MT* op-ed)
- Ethical/respectful fun builds community!
- ELL-friendly scaffolding (e.g., "acquit") and conversational sentence structure
- Most songs work well on mobile devices
- Red/green colorblindness addressed

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The SMILES songs

- 22 + 4 songs
- Most < 2 minutes (some have “long” and “short” versions)
- I coordinated outside songwriters to ensure their work was grounded in learning objectives and spanned intro topics

song topics (aligned with literature, **G**uidelines for **A**ssessment and **I**nstruction in **S**tatistics **E**ducation, **G**oals and **O**utcomes **A**ssociated with **L**earning **S**tatistics instrument)

- Levels of measurement
- Mean vs. median
- Convenience vs. random sampling
- Correlation vs. causation
- Patterns of correlation
- Correlation and slope
- Statistic vs. parameter
- Estimator bias
- Margin of error in poll
- Probability rules
- Effects on width of CI
- Framework of testing H_o
- *p*-values
- Reporting test conclusion
- Concepts of X^2 test
- Effect of *n* on significance
- Concepts of regression model
- Observed/fitted/residuals
- Concepts of ANOVA test
- Variances (not SDs) add
- Bayesian reasoning (most tests for rare traits yield false positives)
- Central Limit Theorem
- Simpson's Paradox
- Ethics in statistics

Example of prosody: “Chi-squared Dance”

- the title is playfully invoked by the entire piece having “square dance” music
- the phrase “a large gap occurred”

  [between observed & expected values]

  is set to a large melodic leap
- the phrase “long right tail” [of the chi-squared distribution] is set to a long descending phrase

Pre-song prompts

- About 5 per song
- More than a quarter contain hints
- 43% involve free response with synthetic voice on playback, the rest are forced-choice answers highlighted on playback but sung with human voice
- 96% require statistical knowledge

Prompts vary in….

format

- Drop down from menu
- Drag-and-drop matching
- Fill-in (numerical)
- Fill-in (words)

Some not revealed before previous questions done, if that would “give away” an answer.

purpose

- Solicit context, example, or variable
- Apply procedure
- Make conceptual connection
- Connections across questions
- Playfulness

Some questions have more than one reasonable answer

Throw That Out?

1. A possible **bad** reason for excluding a point from a data set is just to:

Select

- to fix a typo
- reach significance
- get a round n
- the measurement was done wrong
- remove an inconvenient value
- see no difference

2. excluding a point from a data set is becau

3. organization that establishes rules for the

prompts for “Super Bowl Poll”

Super Bowl Poll

1. Pick your favorite NFL team; if you don't have a favorite, just pick a team you think might be good: Select .

2. The margin of error for a **sample proportion** for a survey of 1000 people would be about _____ %. Hint

3. If 17% is the **sample percentage**, then the **margin of error** you entered in the above item gives an interval estimate as low as _____ % and as high as _____ %.

4. If you multiplied the **sample size** by a factor of nine, that would Select the **margin of error** by a factor of _____ .

   - increase
   - decrease

Continue

Super Boll Poll

Will the **Texans** win next season's Super Bowl?

We asked about 1,000 fans in a scientific poll.

The margin of error was **3** %

That's roughly the reciprocal of the square root of *n*.

17% answered 'YES' in the poll,

But what could it be for the population as a whole?

At the 95% level of confidence

The interval goes from **14** to **20** %.

If we multiply the sample size by a factor of 9,

The new margin of error that we could find

Would be a ***third*** as large as what we had before.

Thanks to the formula, you know the score.

Go **Texans** !

The margin of error was 3 %

STUDIO VERSION

00:18

open-ended prompts solicit context

Regression Rumba

1. Insert the name of a visual graph you could view to decide if there is a linear relationship between the heights and weights of students in your class. Hint

2. For a relationship that interests you, insert the name of a quantitative variable (*Y*) that might play the role of a **response** (i.e., dependent) variable. Please do not use height or weight.

3. For a relationship that interests you, insert the name of the quantitative variable (*X*) that might play the role of an **explanatory** (i.e., independent) variable. Please do not use height or weight.

SONG UNDER CONSTRUCTION

Correlation Illustration Song

1. Think of two specific real-world variables that are quantitative (i.e., a variable whose values are numerical, not something like "eye color") and that should have a (strong or moderately strong) **positive correlation**.

   Give the name of one of the variables:
   Give the name of the other variable:

Correlation Does Not Imply Causation

For questions 1 – 3, consider this sentence:
"She likes to _____ in order to get _____."

1. For the first blank, please give a one-syllable **action verb** that is an activity someone does. Hint

Simpson's Paradox

Please fill in the blanks below with words that are **as short as possible**. Refer to these examples if you need help. Show examples: Example 1 Example 2 Example 3 .

1. Give the name of a group that people could leave or join, comprised of two mutually exclusive types of people or individuals. Hint

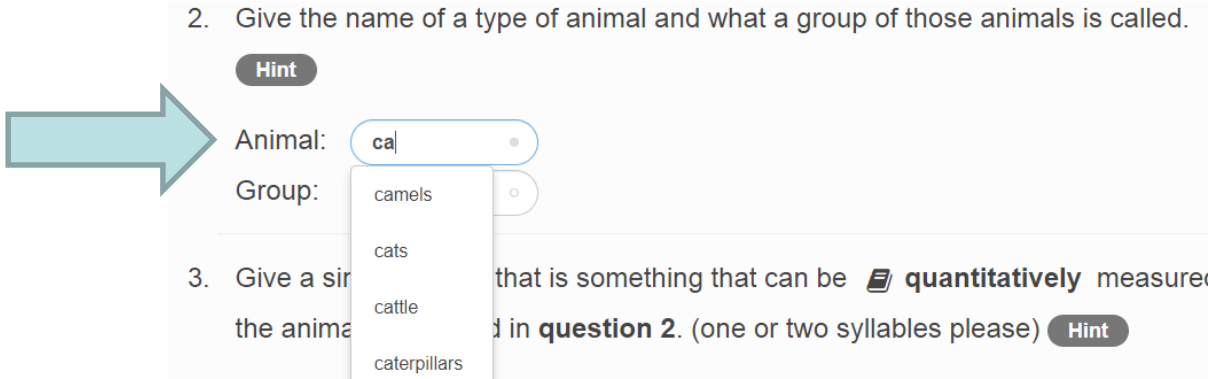
2. Give a general label for any individual in your group (plural noun). Hint

3. Give a label (plural noun) for one type of individual in your group, ideally a type likely to score the higher average measure of your variable. Hint

4. Give a label (plural noun) for a second type of individual in your group, ideally a type likely to score the lower average measure of your variable. Hint

Checks on open-ended inputs

- Auto-corrects close spellings & grammar
- Allows British spelling
- Screens for profanity
- Checks if too many syllables
- Check for values out of range (e.g., $r > 1$) or inconsistent with other answer (sign of r & b)
- Accepts synonyms (scatterplot, scattergram, XY plot; normal, Gaussian, bell-shaped; bigger, larger, greater)
- Suggestions from first letters:

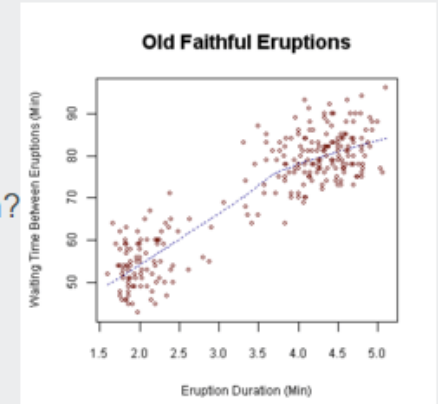


Some reasons for hints:

- not getting an answer could leave a student unduly “stuck” from continuing,
- a definition or symbol is used that a student might not know,
- academic wording of a question might not be clear to all,
- a word might be unfamiliar to someone new to the English language and/or American society,
- we want to teach the student something along the way by giving them a way to deduce the answer rather than repeatedly guess, or
- seeing example or visual may help understand a definition

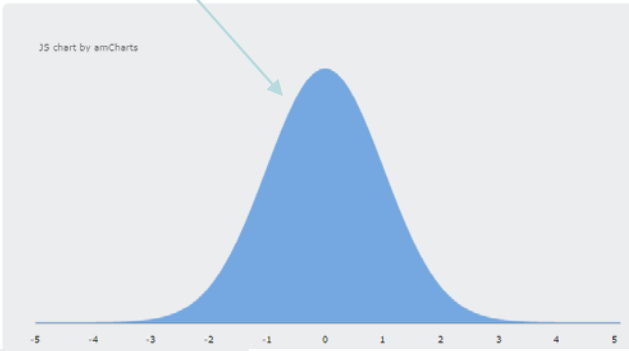
Insert the name of a visual graph you could view to decide if there is a linear relationship between the heights and weights of students in your class. Hint

What is a name for this type of graph?



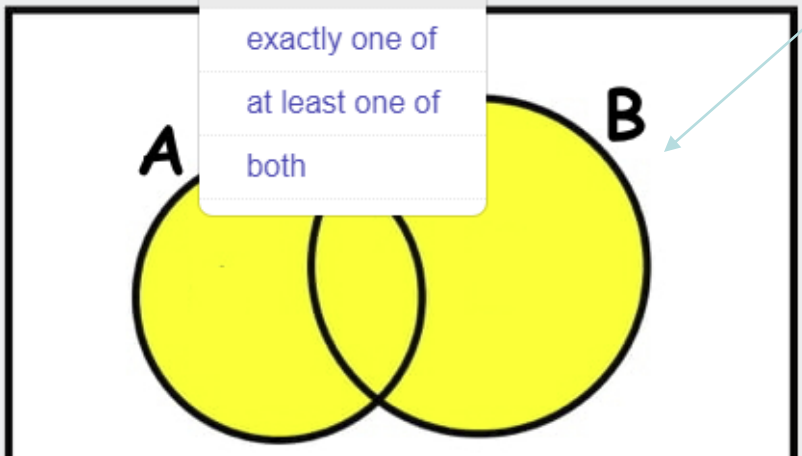
Central Limit Theorem

1. The sampling distribution of means or proportions for large random samples has what shape? Hint



The union of events A or B is often described using the words "A or B" (A ∪ B). This means that Select events A or B happened. Hint

- exactly one of
- at least one of
- both



For a given scatterplot the correlation coefficient and the slope of the regression line would Select share the same sign. Hint

always
sometimes
never

Try pl applet at http://illuminations.nctm.org/Activity.aspx?id=4186 with the “show line of bes ked and watch how r and the slope behave (the slope is the number that x is multip

If we think of the null hypothesis as the person (defendant) on trial, then "failing to reject the null hypothesis" would be analogous to a decision to Select the defendant on trial. Hint

To **convict** means to decide that there **is** a sufficient level of evidence that someone accused of a crime is guilty. To **acquit** means to decide that there **is NOT** a sufficient level of evidence that someone accused of a crime is guilty.

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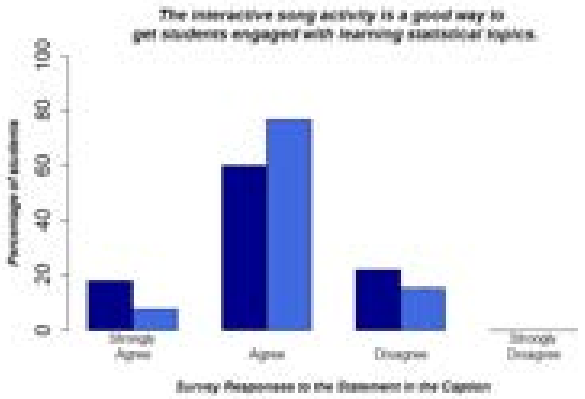
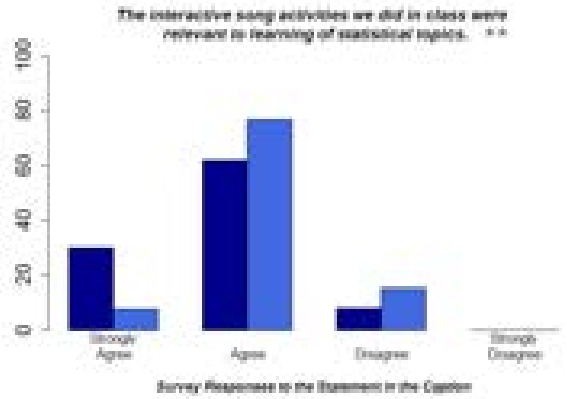
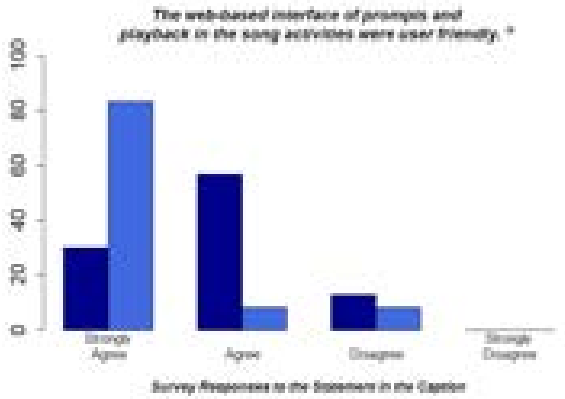
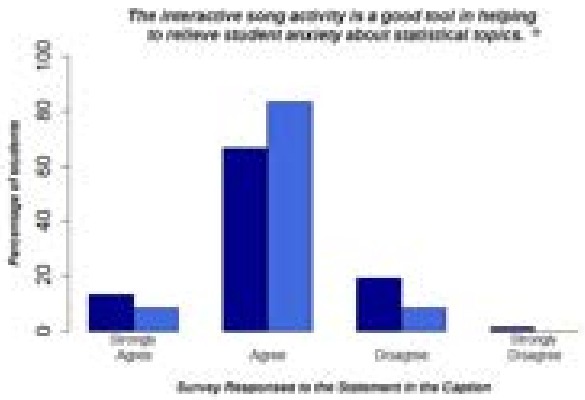
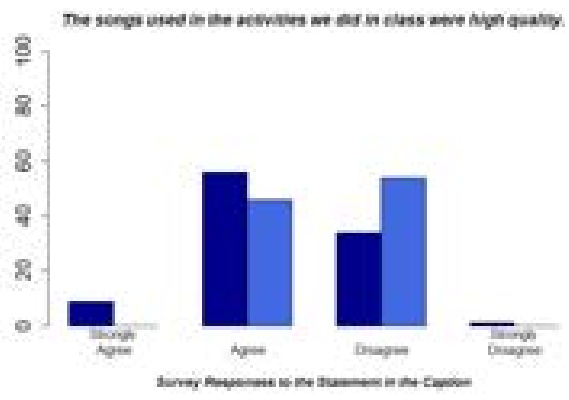
spring/summer 2017 pilot [at research univ. (dark bars) and 2-year college]: students agreed songs were engaging, relevant, user-friendly, & anxiety-reducing, but split on “high quality”











and we're analyzing results of these student-randomized trials

	Fall 2017	**Spring 2018**
2-year college (mostly Black)	4 instructors, 12 sections	6 instructors, 15 sections
Research university		1 section (115 students)
Control Group	readings only	readings only
Treatment Group 1	SMILES platform, but not readings	SMILES platform, but not readings
Treatment Group 2		readings and (noninteractive) studio versions of songs

OUTLINE

- Background
- Inspirations
  & Guiding Criteria
- Songs from the Collection
- Lessons Learned from Field Trials
- *Tips for Use*
- Q&A

67 TLC

Full STEAM Ahead: Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs!

General Interest Session

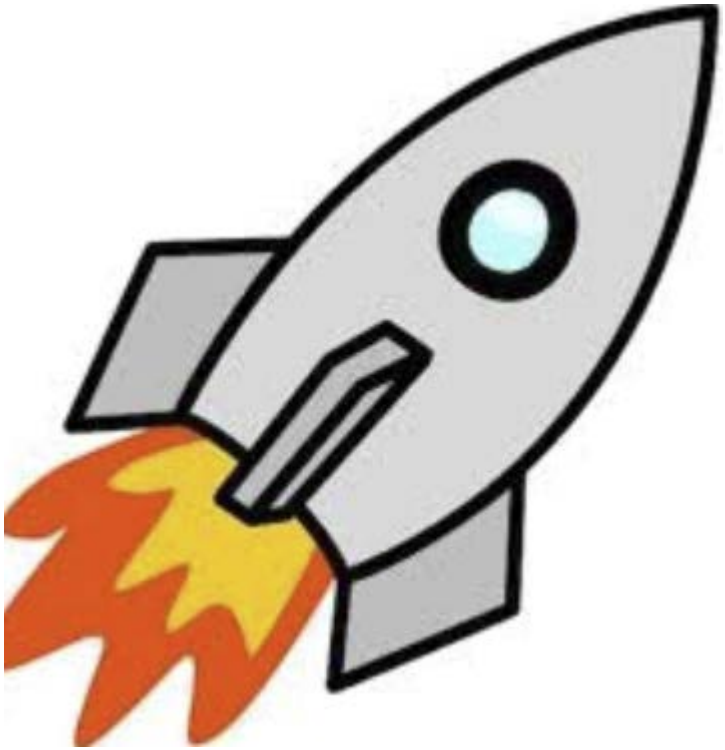
NSF, NEA, and Kennedy Center projects have used STEAM to reach diverse students. Our NSF-funded Project SMILES created 22 "interactive songs" for teaching intro statistics, and our approach applies also to other STEM courses. We share our guiding criteria, discuss field trials on engagement and effectiveness for learning, and discuss tips for use.

Lawrence Lesser
The University of Texas at El Paso
Dennis Pearl
Columbus, Ohio
John Weber
Perimeter College at Georgia State University, Clarkston

Walter E. Washington Convention Center, 154 AB

launching by May 14, 2018!

https://www.causeweb.org/smiles/



Song Library

1. A Fitting Conclusion – 0:42

   Apply relationships among alpha level, *p*-value, and the decision of a hypothesis test.

   Build a Song | Studio Demo | View Reading

2. A Radical Approach – 0:35

   Understand that standard error changes with the square root of the sample size.

   Build a Song | Studio Demo | View Reading

3. ANOVA – 2:46

   Recognize the conceptual idea of ANOVA as comparing *within* to *between* variance.

   Build a Song | Studio Demo | View Reading

4. Central Limit Theorem – 1:12

   Recognize when the Central Limit Theorem applies.

   Build a Song | Studio Demo | View Reading

5. Chi-Squared Dance – 1:35

some longer songs have short versions

11. Everything's Unusual (Long) – 3:57

Reason how larger sample sizes decrease the *p*-value, all else being equal.

Build a Song | Studio Demo | View Reading

12. Everything's Unusual (Medium) – 3:25

Reason how larger sample sizes decrease the *p*-value, all else being equal.

Build a Song | Studio Demo | View Reading

13. Everything's Unusual (Short) – 2:44

Reason how larger sample sizes decrease the *p*-value, all else being equal.

Build a Song | Studio Demo | View Reading

19. My Family's Mean (Long) – 3:14

Reason about mean and median, and the effect of an outlier.

Build a Song | Studio Demo | View Reading

20. My Family's Mean (Short) – 1:28

Reason about mean and median, and the effect of an outlier.

Build a Song | Studio Demo | View Reading

Tips for Using SMILES

- Choose songs whose learning objectives align with your curriculum/notation
- Use introduce or review a topic
- Use to break up or vary a lecture
- Try whole-room teacher-led mode (drop-down prompts can be clicker questions, fill-in items be class discussion items) or have students with earbuds in lab mode
- Formative assessment (though website lets teachers access a MC exam item)
- Let students write their own 

Benefits of student-created songs

(Crowther et al., 2017)

compact phrasing required by a lyric (vs. prose) forces the writer

to more deeply engage with the concepts to get to the essence,

and this process can not only consolidate existing knowledge

but also generate new insights

Guidance on Student-Written Songs

- See my May 2018 eCOTS videoposter for rubric, assignment sheet, resources/tips
- Due 2 weeks before end of term so it could synthesize or review material from any part(s) of the course
- Don’t require performance/display
- Allow teamwork
- Make it extra-credit
- Limit length to 3 minutes

eCOTS 2018 is May 21-25, 2018

- Includes access to keynotes, breakout sessions, virtual posters, birds-of-a-feather gatherings, and workshops such as our

live 2-hour workshop on the using the (then-released) SMILES collection!

- Registration: only $25

these ideas apply across STEM!

have STEM colleagues browse archived 2017 VOICES meeting and save the date for Sept. 26-27, 2018!

(STEM-focused, almost free, pedagogy/research/practitioner angles)
causeweb.org/voices/

VOICES

2017 Virtual Ongoing Interdisciplinary Conferences on Educating with Song

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thanks for attending Full STEAM Ahead:

Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs

WE WELCOME YOUR QUESTIONS & FEEDBACK

Larry Lesser

The University of Texas at El Paso

Lesser@utep.edu

smiles@causeweb.org

http://www.math.utep.edu/Faculty/lesser/Fun.html

Join us Sept. 26-27 at VOICES (causeweb.org/voices/)

18-second fill-in-the-blank song…

….I wrote to help my HS geometry students recall & distinguish 2 main circle formulas

using the tune that helped us all learn the alphabet!

“Circle Song”

you complete each rhyme!

Take your finger ‘round a jar --

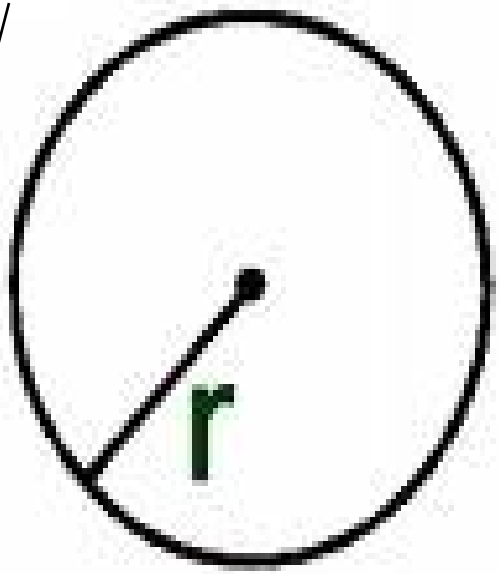
Circumf’rence equals 2 pi ____;

For area, you multiply

R squared by that number ____.

Twinkle, twinkle, you’re a star

Knowing math will take you____!



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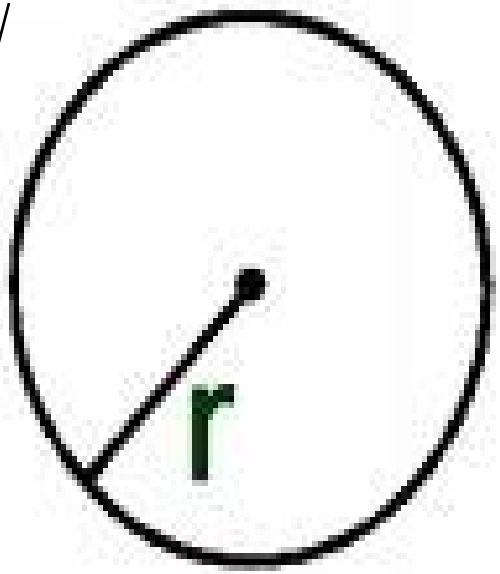

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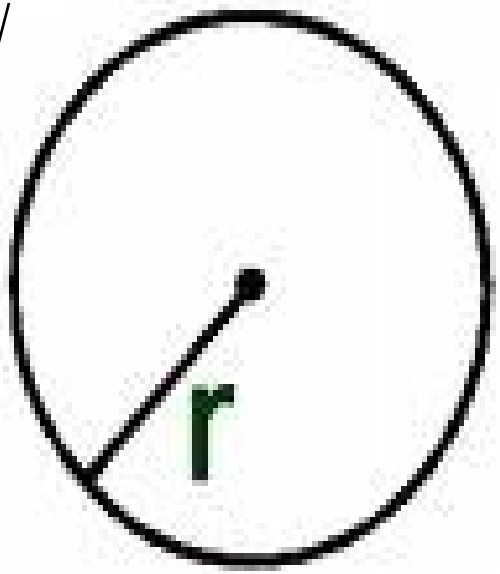

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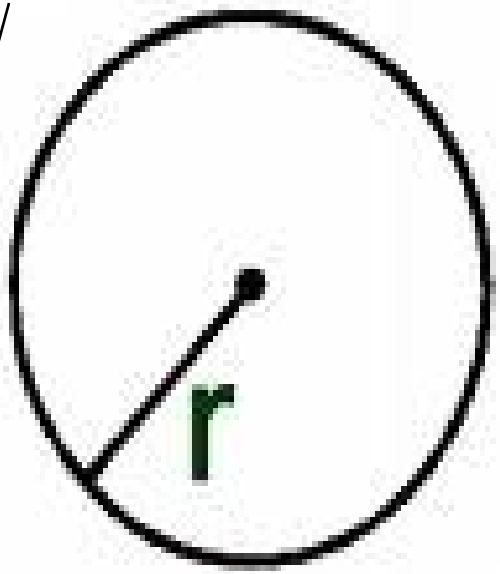
R squared by that number pi.

Twinkle, twinkle, you’re a star

Knowing math will take you far!



Circle Song
by Lawrence Mark Lesser

Take your finger 'round the jar:
Circumf'rence equals $2\pi r$!
For area, you multiply
r squared by that number π.
Twinkle, twinkle, you're a star:
Knowing math will take you far!

song supports recall and motivates concepts

Lesser (2014), *JMA*

The first couplet, in addition to providing a concrete example of an object with a circular part, has end rhyme that forces students to realize that the missing letter must be *r*, not *d* (thus helping them recall the correct formula later).

The third couplet concludes the song with a math-positive affirmation.

The second couplet helps them recall another formula and reminds them that π is just a number (though represented by a letter) and its attention on an '*r* square' (i.e., a square whose side has the length of the radius) gives non-calculus intuition into the plausibility of the area formula.

Flores & Regis (2003), *MTMS*

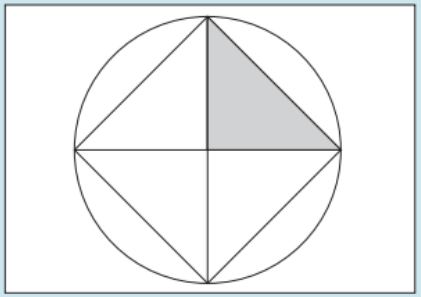


Fig. 2 The shaded triangle is one-half of the radius square.

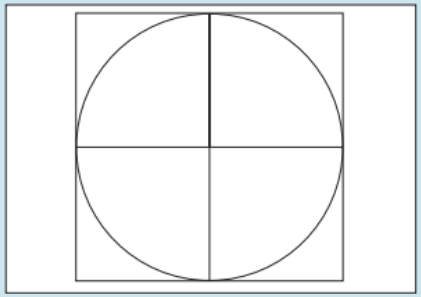


Fig. 3 The area of the circle is less than the area of four radius squares.

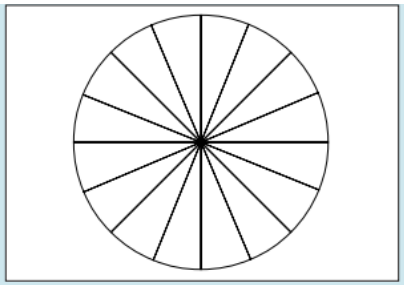


Fig. 9 A circle cut into sixteen slices

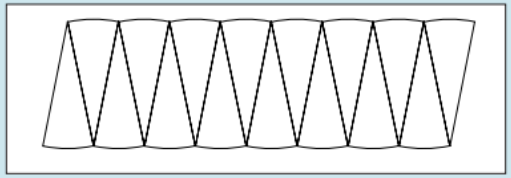


Fig. 10 The slices of the circle rearranged

part of our larger ongoing efforts…

http://www.math.utep.edu/Faculty/lesser/Fun.html

- Nov. 2008 *J. of Statistics Education*: review paper of 20 modalities of fun (e.g., humor, songs, games, cartoons) in statistics education
- March 2013 *J. of Statistics Education*: survey of 249 statistics instructors on **hesitations** and motivations for using fun
- Spring 2014 *J. of Mathematics and the Arts*: rationale, strategies, and resources for using **lyrics** in mathematics/statistics class
- June 2015 *Transformative Dialogues*: **case study** of an instructor's use of fun (including song) in statistics
- July 2016 *J. of Statistics Education*: randomized experiment on fun **inserts** (e.g., songs or cartoons) into intro statistics readings in LMS
- June 2016: *To Improve the Academy*: survey on use of song in **educational development**

findings of experiment

(see July 2016 *Journal of Statistics Education*)

- **Learning**: embedded questions on items related to songs were answered correctly 50.0% of the time by experimental group (n = 80) and 42.3% by control group (n = 88); 2-tailed p = .04

- **Attitudes** (*post-SATS): Little/no difference between experimental (n = 44) and control (n = 44) groups; not surprising since attitudes are more stable than anxiety
- **Anxiety** (*post-SAM): no significant difference between experimental (n = 53) and control (n = 59) for the small sample sizes, but trending towards positive effect

*= not enough students took pre AND post
to test pre-post differences with adequate power

Lyrics need more than rhyme

(Lesser, 2014)

- Letter combinations must be singable, and have grammatical phrasing aligning with musical pauses
- Must have conversational word order (e.g., subject-verb-object) and rhythm; avoid ambiguous homonyms and long clauses to communicate by ear on first listening
- Place key words where there are end rhymes, long notes, downbeats, or repetition
- Melody conveys meaning

had role in my 2016 statewide teaching award

By Lisa Y. Garibay

University Communications

An educator with a passion for combining math and music has helped The University of Texas at El Paso continue its strong tradition with one of Texas' most prestigious academic awards.

"Mathemusician" Larry Lesser, Ph.D., has become the 14th Piper Award recipient for UTEP.

The Minnie Stevens Piper Foundation in San Antonio established its award in 1958 to honor professors for their dedication to teaching and their community. Every May, the foundation selects 10 winners from among all two- and four-year colleges and universities in Texas.