2018 NCTM Annual Meeting and Exposition

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

Larry Lesser (The University of Texas at El Paso)

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

Student-Made Interactive Learning with Educational Songs (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!
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
songs often written/discovered via national contests!

Registration is closed for this event

Open Set 2018 - MoMath’s Song Contest

Make 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

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

Lesser et al. (2013)
Mathematical lyrics: noteworthy endeavours in education

Lawrence M. Lesser

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(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 education include the many songs of Tom Lehrer [63], and more recently, Steve Sodergren [55] and The Fifth Moment [1]. While songs can build community among students, the mathematics and statistics songs are often performed in some of the more advanced mathematics and statistics courses.
“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
latest work…

- Archived presentation for VOICES 2017: https://www.causeweb.org/voices/2017/panel/1-3
- “early view” 2018 paper in *Teaching Statistics*
- May 2018 workshop & videoposter at eCOTS
- July 2018 paper at ICOTS
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.
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
2015 - present     NSF EAGER grant (DUE 1544426, 1544237, 1544243)

Project

Student-Made Interactive Learning with Educational Songs (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
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
song topics (aligned with literature, Guidelines for Assessment and Instruction in Statistics Education, Goals and Outcomes Associated with Learning Statistics 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 $H_0$
- $p$-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
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
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
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
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/](causeweb.org/voices/)
thanks for attending Full STEAM Ahead:  
Engaging, Empowering, and Educating Students with Interactive (Statistics) Songs

WE WELCOME YOUR QUESTIONS & FEEDBACK

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smiles@causeweb.org
http://www.math.utep.edu/Faculty/lesser/Fun.html

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