

Using Web-Based Interactive Songs to Helping Students Learn Statistics

Presenter & Co-PI

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Nautilus 4

Acknowledgement:

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Previous Student-Randomized Experiment

- Fall 2013; 53 Students from two-year college; 194 from medium-sized university
- Half the students randomized to always have “fun inserts (song, cartoon, etc.)” in content mini-readings accessed via LMS
- All students take exams with 12-14 embedded MC items related to readings
- Readings with embedded songs showed 7.7% (p-value ≈ 0.04) more correct responses than control group.

Lesser, L.M., Pearl, D.K., & Weber, J.J. (July 2016). Assessing fun items' effectiveness in increasing learning of college introductory statistics students: Results of a randomized experiment. *Journal of Statistics Education*, 24(2), 54-62.

<http://tandfonline.com/doi/pdf/10.1080/10691898.2016.1190190?needAccess=true>.

Continuum of Song “Interactiveness”

- Listen to recording
- Listen to performer
- Provide accompanying rhythm
- Sing along (with lyric displayed)
- Complete each rhyme with only 1 right answer
- Provide inputs to help create the song
- Write your own song (with scaffolding offered)

Interactive Song

Songs work well for recall because more interactive

Each song has the following properties:

- engaging to students and require their active input;
- machine gradable to provide rapid feedback;
- online for out-of-class use to avoid an instructor time burden;
- easy to use to avoid frustration and wasted ramp-up time; efficient in making impact per student time on task;
- high aesthetic value;
- grounded in core learning objectives;
- usable in a manner within the instructor's comfort zone; and
- amenable to experimental testing of their efficacy for our goals of increased learning and reduced anxiety.

The SMILES Song Library

aligned with literature

- **Guidelines for Assessment and Instruction in Statistics Education, and**
- **Goals and Outcomes Associated with Learning Statistics instrument.**

- A Fitting Conclusion (0:42)
- A Radical Approach (0:35)
- ANOVA (2:46)
- Central Limit Theorem (1:12)
- Chi-squared Dance (1:35)
- Correlation Does Not Imply Causation (3:33)
- Correlation Illustration Song (1:27)
- Correlation Song (0:34)
- Don't Buy a Carpet (1:30)
- Estimation Notation: It's Greek (and Roman) to Me (1:10)
- Everything's Unusual (2:44)
- Height of Confidence (2:42)
- Hypothesis on Trial (1:38)
- Inferential & Descriptive Stats (1:27)
- It Might Not Be That Bad (3:03)
- Levels of Measurement (2:01)
- My Family's Mean (3:14)
- Probability Rules Rap (1:02)
- Regression Rumba (1:46)
- Simpson's Paradox (2:13)
- Super Bowl Poll (1:28)
- Target Practice (1:08)
- The Enlightened Teacher (1:55)
- Throw That Out? (1:36)
- What p -value Means (0:12)
- Y Hat Dance (0:57)

Demo of Interactive Song

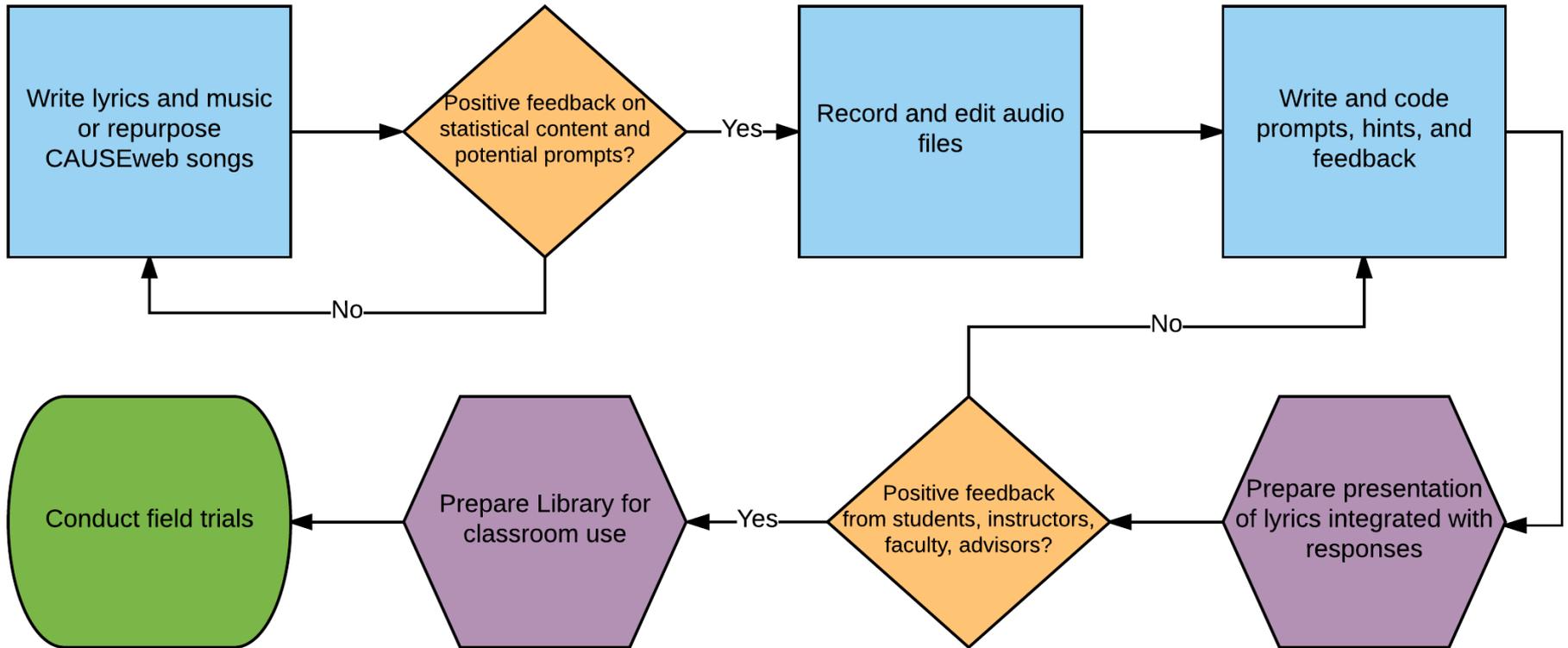
https://dev.stat.vmhost.psu.edu/smiles/songs/regression_rumba



Prompts/User Inputs

1. Statistical concept
 - 58 multiple choice prompts – 8 with hints
 - 16 free response prompts – 4 with hints
 - Evaluated for correctness, spelling, profanity, syllable counts
 - Hints/feedback provided based on responses
2. Statistical example
 - 4 multiple choice prompts
 - 12 free response prompts – all with hints
3. Some hints/feedback correspond to one of the following conditions:
 - a. not getting an answer could leave a student unduly “stuck” from continuing,
 - b. a word (e.g., acquit) might be unfamiliar to someone new to the English language and/or American society,
 - c. we want to teach the student something along the way by giving them a way to deduce the answer rather than repeatedly guess, or
 - d. seeing an example or visual may be helpful in understanding a definition.

Development Workflow

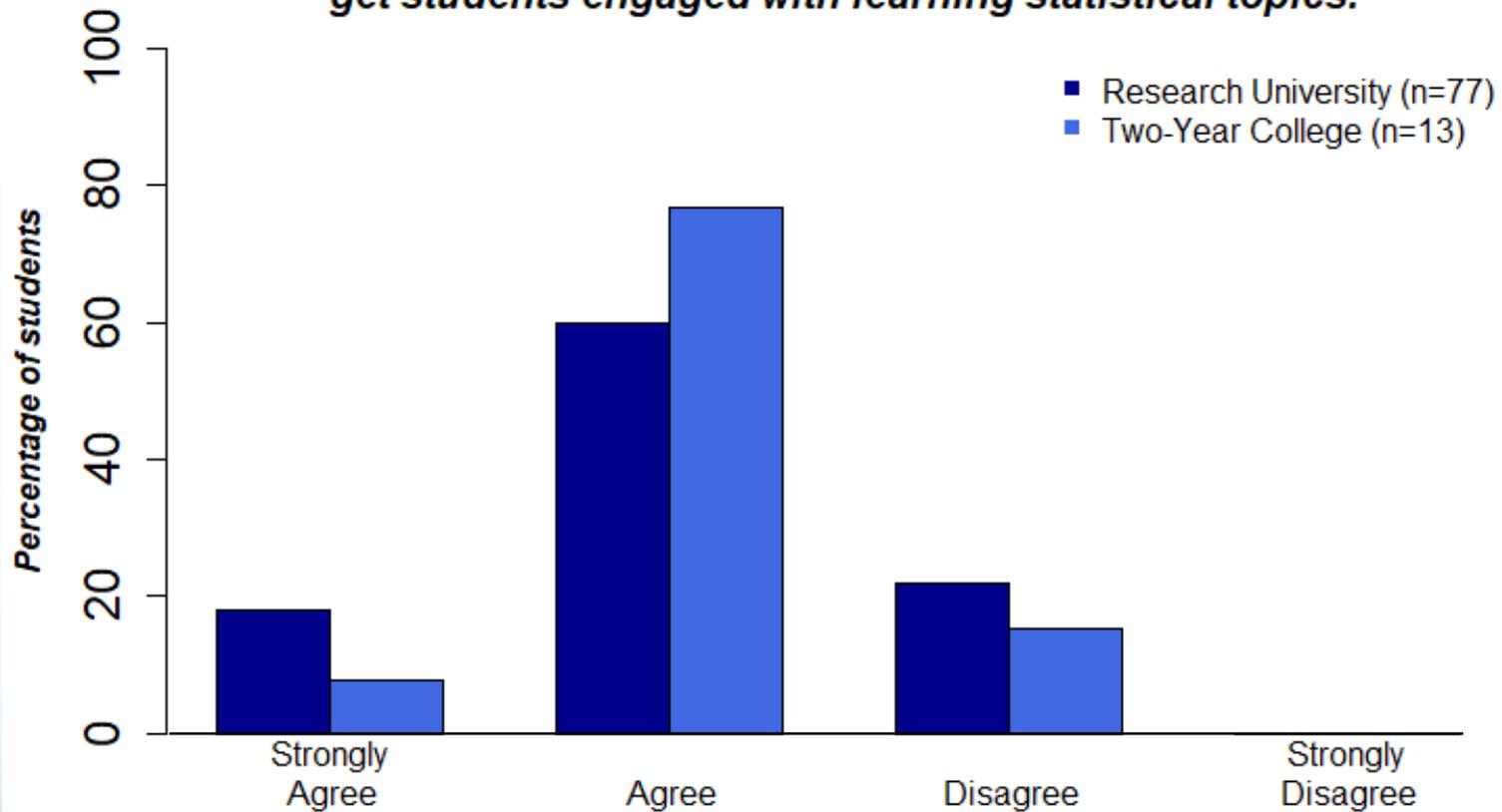


Songwriting Challenges for Songs with Inputs

- Key content words are ideally in important positions such as end rhymes, but free-choice inputs are unlikely to maintain the (unseen) rhyme.
- Need to have a “sweet spot” for number of syllables for student inputs.
- Fixed-choice options must be checked for singability.
- Transitions between human and synthesized voices must preserve melodic integrity and intelligibility.

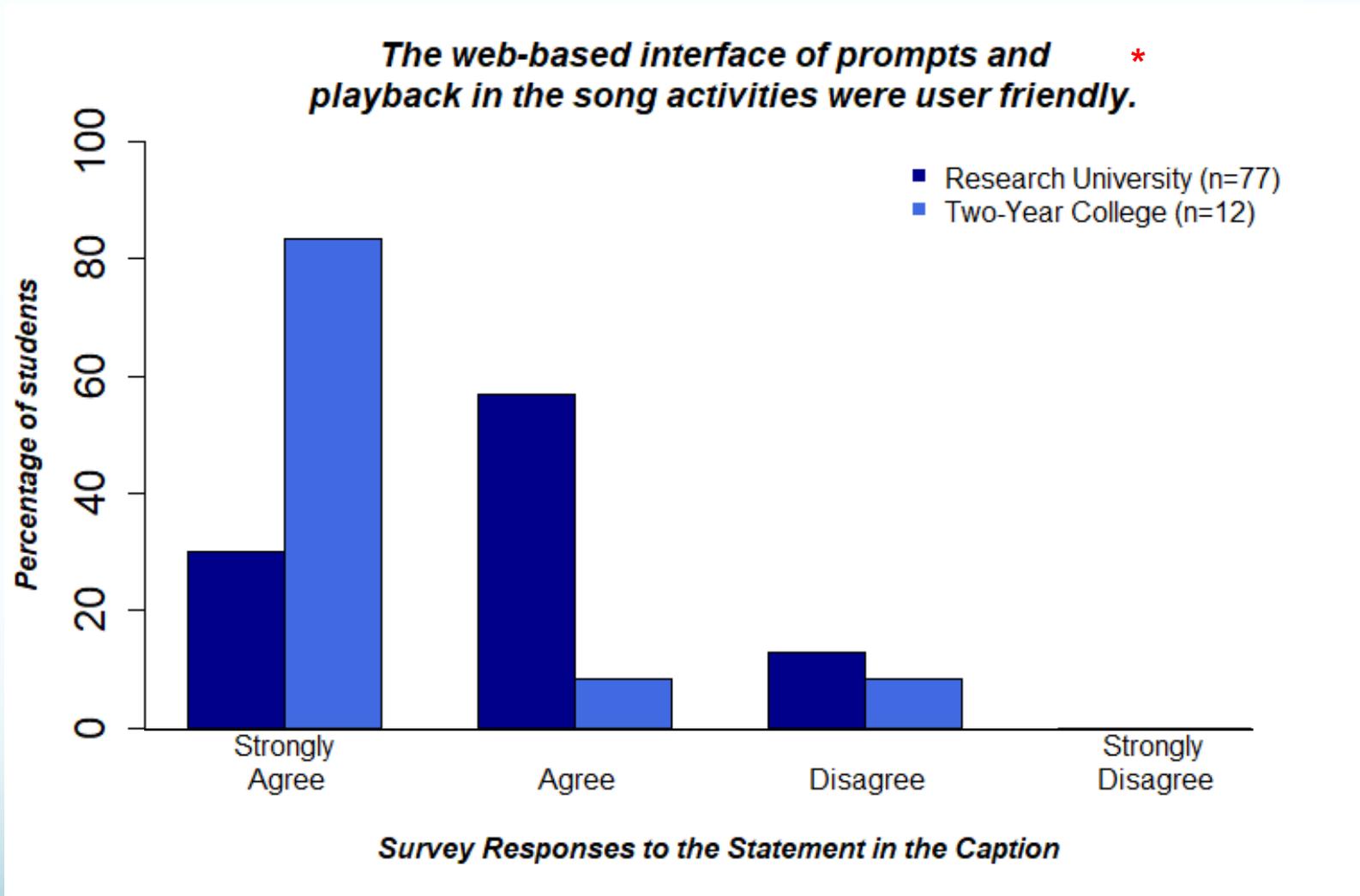
Student Feedback Study

The interactive song activity is a good way to get students engaged with learning statistical topics.



Survey Responses to the Statement in the Caption

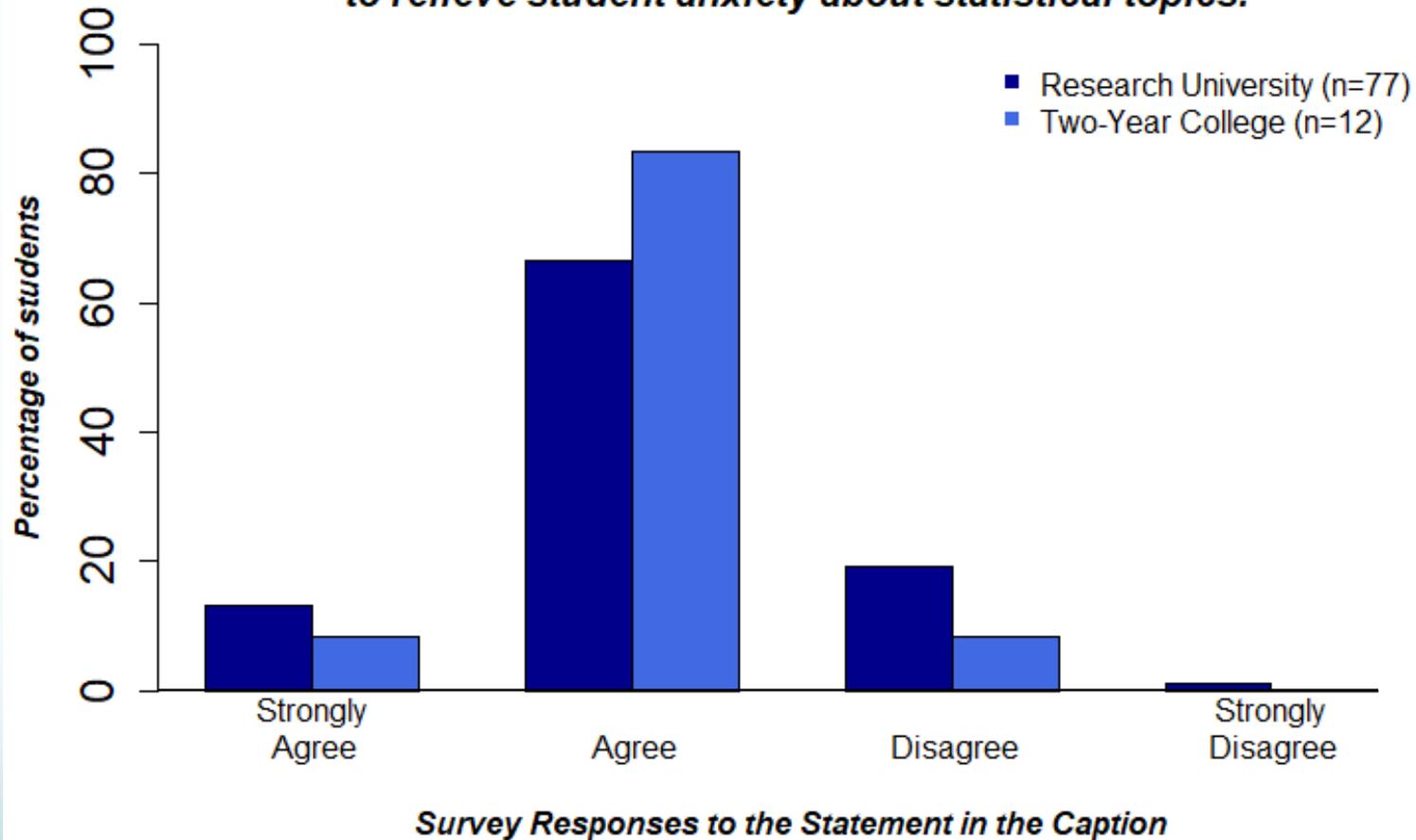
Student Feedback Study



Student feedback from pilot study at research institution (dark blue bars; n=77) and two-year institution (light blue bars; n=12^{*}).

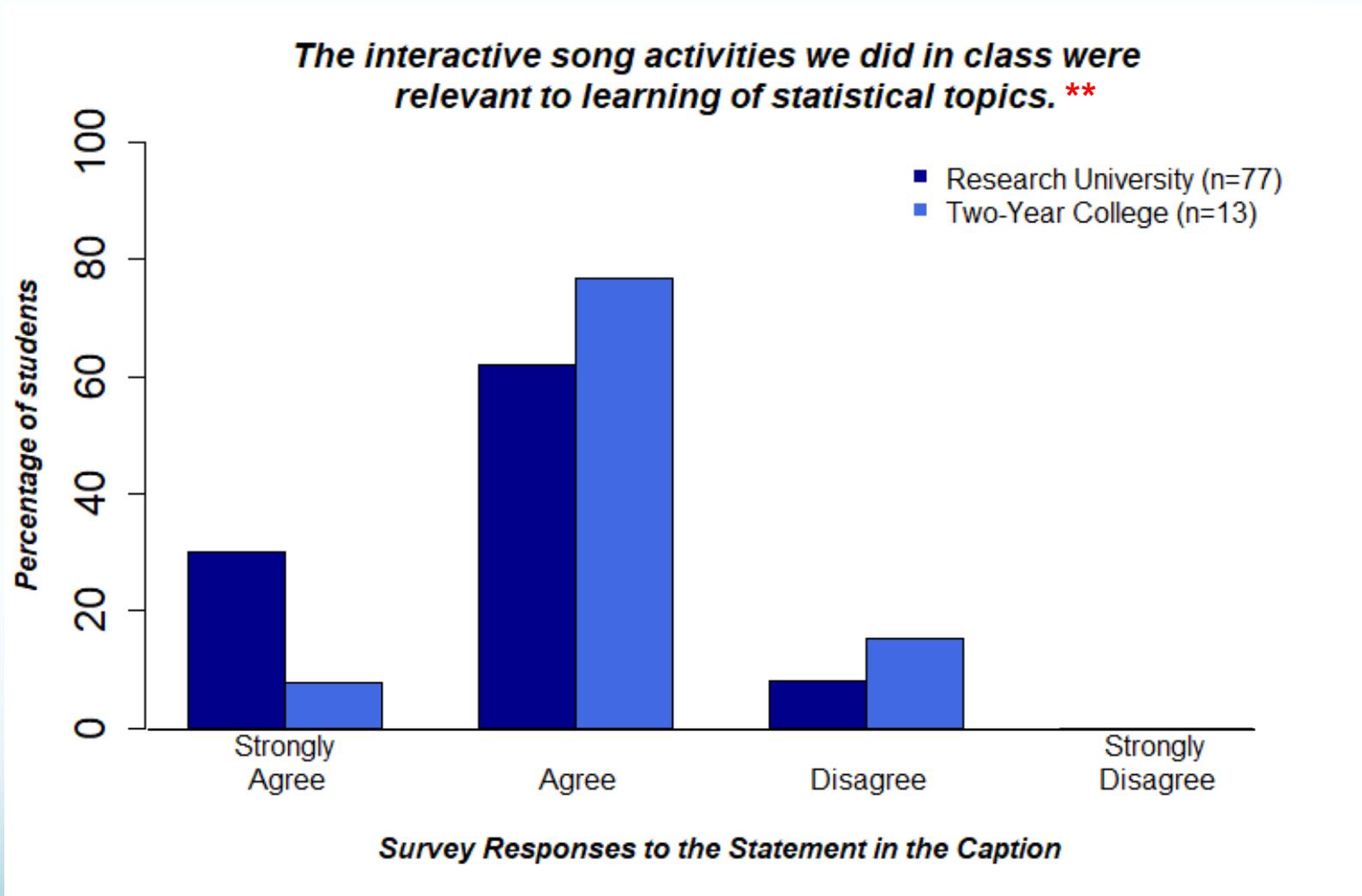
Student Feedback Study

***The interactive song activity is a good tool in helping *
to relieve student anxiety about statistical topics.***



Student feedback from pilot study at research institution (dark blue bars; n=77) and two-year institution (light blue bars; n=12).*

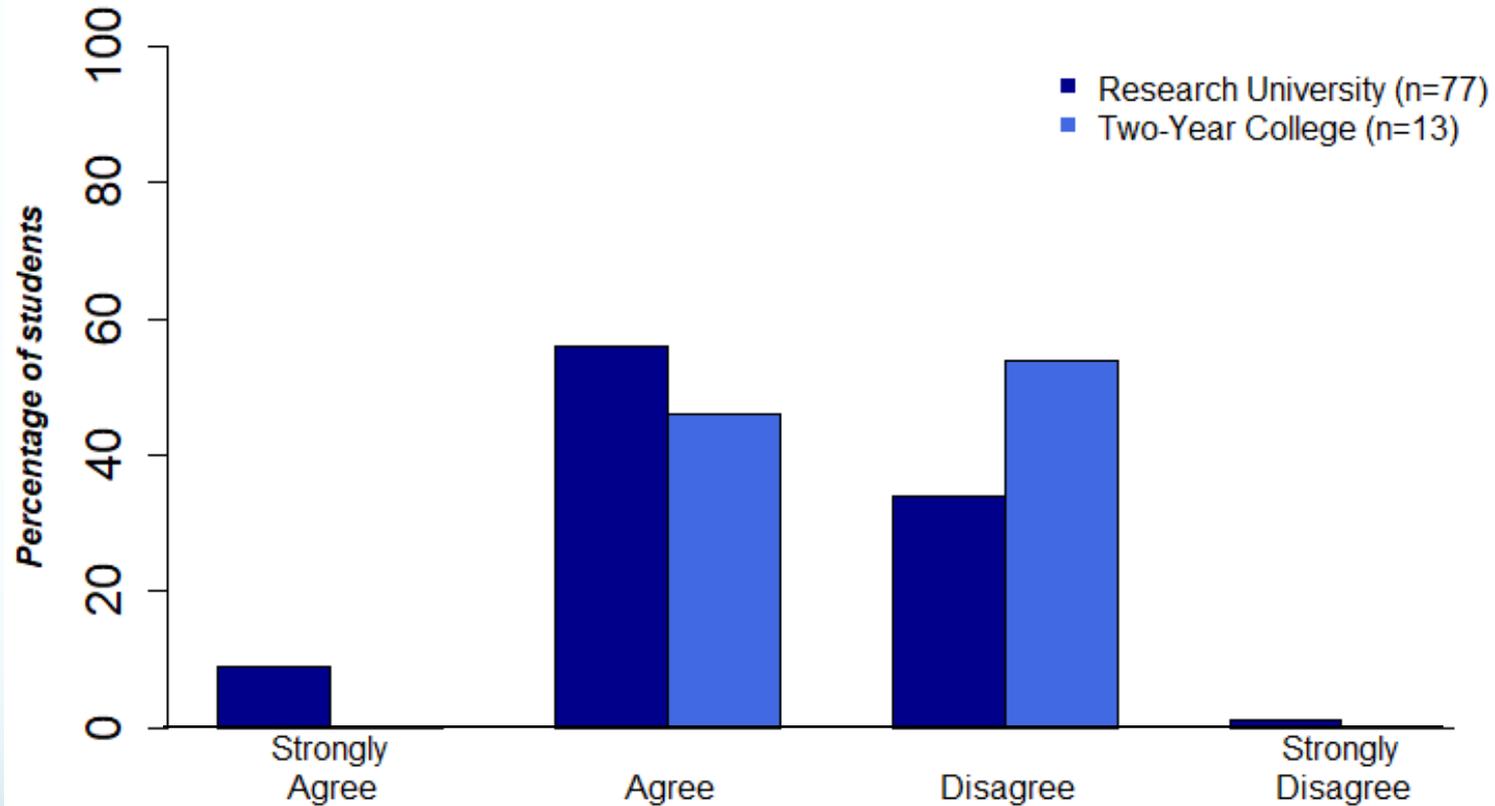
Student Feedback Study



****** *The wording at the two-year institution included the word “my” before “learning.”*

Student Feedback Study

The songs used in the activities we did in class were high quality.



Survey Responses to the Statement in the Caption

Representative Student Comments

(# of similar comments in parentheses)

Praise:

- Helpful in learning (20)
- Easy to use interface (15)
- Enjoyable (7)
- Engaging (7)
- Reduces stress and anxiety (6)
- Songs nicely produced (6)
- Entertaining (4)
- Helpful lyrics (4)
- Answering questions helps (3)
- Questions involved me (1)
- Motivating (1)
- Interesting (1)
- Catchy songs (1)
- “It’s a neat tool” (1)

Representative Student Comments

(# of similar comments in parentheses)

Suggestions:

- Make songs more fun, e.g., catchier beat (17)
- Improve sound quality (10)
- Make website more user-friendly or more directions for use (6)
- Add more topics and explanations (4)
- Use more questions and less songs (2)
- Songs did not focus enough on content (1)
- Lyrics are too cheesy (1)
- Not practical for use (1)

Pre/Post Knowledge

- As part of Spring Pilot Study at research institution students answered assessment questions in evening
- **Example 1: Levels of Measurement**
 - Question/Prompt 2 asks students to find real examples of nominal/ordinal/interval/ratio.
 - Input data showed 34% got this right the first time.
 - In follow-up assessment, students were asked to identify level of measurement for allergy rating of pet dog (low, medium, or high); weight of pet dog; body temperature of pet dog ($^{\circ}\text{C}$); and breed of pet dog
 - 82% got all four correct

Pre/Post Knowledge

- **Example 2: Height of Confidence**
 - Questions 1 and 3 asked students what happens to CI with a larger n (Q 1) and with a higher level of confidence (Q 3)
 - Input data showed
 - 64% got question 1 correct on first try
 - 62% got question 3 correct on first try
 - In the follow-up assessment, students were asked to order CIs from widest to narrowest amongst
 - a. $n = 500$, with 80% confidence,
 - b. $n = 100$, with 99% confidence,
 - c. $n = 500$, with 95% confidence, and
 - d. $n = 100$, with 95% confidence
 - 62% got this right (b then d then c then a)

Pre/Post Knowledge

- **Example 3: Super Bowl Poll**
 - Question 4a and b asked students if n goes up by a factor of 9 then the MOE would go (up or down = Q 4a) by a factor of (fill in 3)
 - Input data showed 97% got 4a correct (MOE would decrease) only 15% got the factor right on the first try. Note that this was after Height of Confidence that might have helped with 4a
 - In the follow-up assessment, students were asked to identify the factor by which MOE would change when sample size decreased by a factor of 4
 - 58% got this correct (bigger MOE by double)

Future Directions

- Other Music-in-STEM initiatives
 - VOICES Conference [<https://www.causeweb.org/voices/>]
 - Archives from 1st conference available at above link
 - 2nd Annual Conference will be next fall
- Interdisciplinary Collaborators
 - Music Educators – using music to teach STEM [STEAM]
 - Music Technologists – using synthetic voice
- VOICES Initiative
 - extending evidence-based innovations in the active learning of STEM with song across diverse student populations, multiple disciplines and multiple education levels;
 - launching interdisciplinary research efforts that would allow broader generalization of the effectiveness of song in STEM interventions across disciplines;
 - sharing research methods, assessment instruments, professional development strategies, resource portals and other technologies in this area across disciplines and education levels.

Some References & Resources

- 2013 *JSE* paper on instructor Hesitations & Motivations
www.amstat.org/publications/jse/v21n1lesser.pdf
- 2014 *JMA* paper on Math/Stat Lyrics
www.tandfonline.com/doi/pdf/10.1080/17513472.2014.950833
- 2016 *JSE* paper on Effectiveness of Song
www.tandfonline.com/doi/full/10.1080/10691898.2016.1190190
- CAUSEweb Fun Resources
www.CAUSEweb.org/resources/fun/references
- A Continuum of Interactivity with Educational (Mathematics/Statistics) Songs, invited talk, Sept 2017, VOICES, by Larry Lesser
<https://www.causeweb.org/voices/2017/panel/1-3>
- VOICES poster presentation, Sept 2017, by Dennis Pearl & John Weber
<https://www.causeweb.org/voices/2017/poster/8>
- Sing about Math & Science
www.singaboutscience.org
- Additional links to work produced by presenters
<http://www.math.utep.edu/Faculty/lesser/Fun.html>

Questions and Feedback

What are your questions?

Any Suggestions or Feedback?

Interested in signing up for VOICES email list?

<https://www.causeweb.org/voices/intro>

Thank You

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