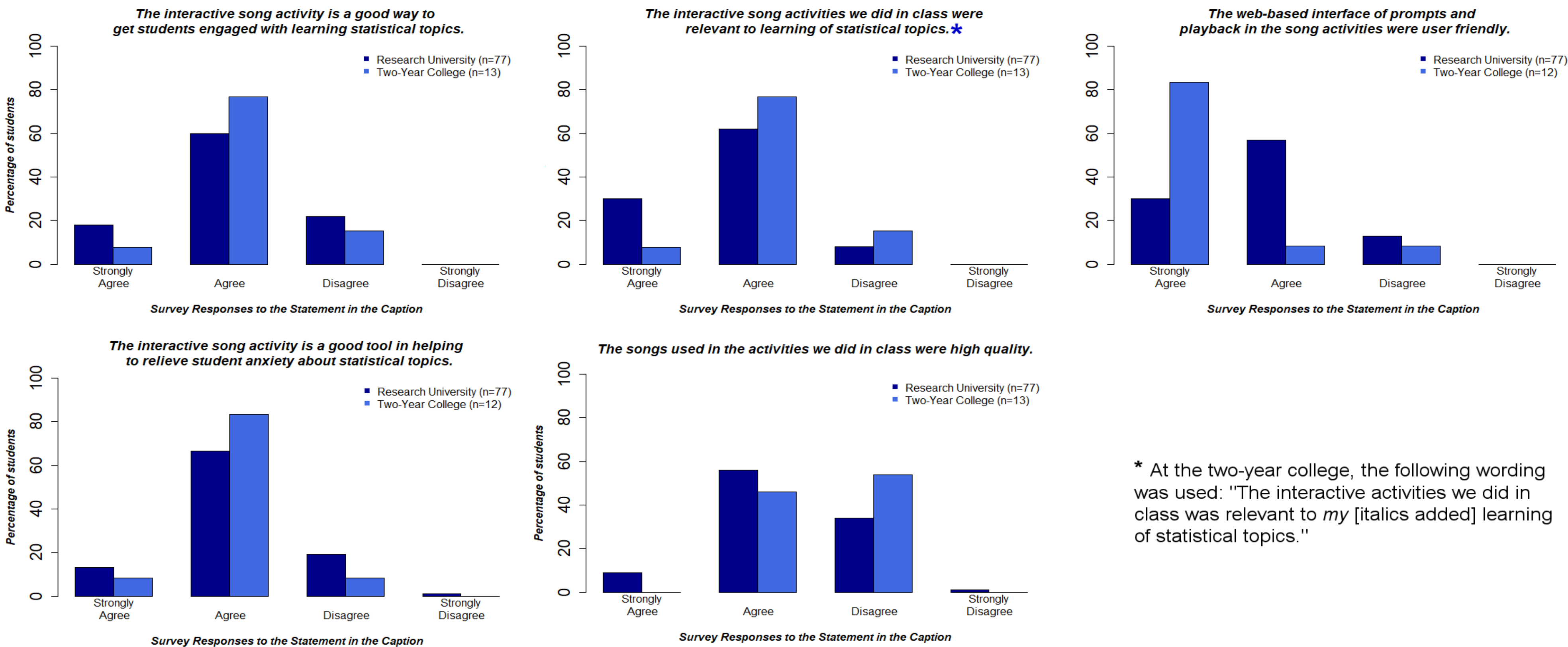


Using song in higher education spans many scientific disciplines (e.g. www.CAUSEweb.org/voices) and has many putative benefits, including reduced stress or anxiety, improved recall, and increased motivation or engagement (Crowther et al., 2016; Crowther, 2016; Lesser, 2014). Based on prior findings (Lesser et al., 2016), we have developed a new web-based resource for teaching with song where students interact with online prompts to make conceptual connections and provide examples that become part of a song highlighting their contributions (www.CAUSEweb.org/smiles). Twenty-seven songs covering many introductory statistics topics were developed along with the associated prompts and assessment items to test their efficacy for learning.

Ninety students from two institutions (one research university and one two-year college) were asked to respond to Likert scale items on agreement with key project goals. Students self-reported the tool was helpful in reducing anxiety, increasing engagement with the material, being relevant to their learning, and having a user-friendly interface.

Figure 1. Student Responses to Likert Items in Student Feedback Study



Results for Prompts

✓ As expected, students using the interactive songs in-class overwhelmingly completed all of the prompts in a single session while students at home were less likely to do so. The value added by the songs can be seen in the percentage of students giving correct responses to specific prompts and then asking about the same material in a different context after the song activity (Table 1).

Table 1. Completion Rates and Assessment Results for Songs in Pilot Study

Song	Completion of Prompts		In-class Assessments		
	In-class % students	Out-of-class % sessions	Pre-song % correct	Post-song % correct	Learning Objective
"Levels of Measurement"	99%	46%	34%	82%	Identify data type in context
"Height of Confidence"	98%	66%	40%	62%	Effect of n & CI level on CI width
"Super Bowl Poll"	87%	41%	15%	58%	MOE varies with square root of n

Levels of Measurement

1. Here are brief definitions of four levels of measurement in scrambled order:

- A **ratio** variable is a numerical variable where the value of zero indicates an absence of the quantity being measured.
- An **ordinal** variable is a categorical variable that has a natural ordering to the possibilities.
- A **nominal** variable just puts values into groups without any ordering.
- An **interval** variable is a numerical variable where differences between values make sense but ratios do not.

Drag the variable types into the slots for order of increasing information content:

☒ nominal ☒ ordinal ☒ interval ☒ ratio

2. Pick four variables that interest you so that you have one variable of each type and then drag them into the corresponding slots below.

Calendar Year Cancer Stage Engine Weight Eye Color Favorite Class Family Size Film Rating (5-star scale) Gender Genotype Grade in Course (A, B, C, D, F) Grade Points Hair Color Heart Rate (beats per minute) Height (inches) Housing (own, rent) Mileage (miles per gallon) Net Worth (dollars) Pain Level (none, mild, excruciating) Race Rainfall (inches) Religion Shoe Size Soldier Rank Temperature (°F) Temperature (Kelvin) Threat Alert (low, guarded, elevated, high, severe) Time of Day T-Shirt Size Type of Pet U.S. State Weight(pounds) Year in School

Nominal:

Ordinal:

Interval:

Ratio:

Levels of Measurement

Nominal, ordinal, interval, ratio are levels of measurement. Let's show that progression with examples that we present.

With a variable that's **nominal**, values are just like names. So ordering or averaging **genotype** would really be a shame!

A variable that's **ordinal** sorts values like a chain, But don't assume with **pain level** each jump would mean the same!

With a variable that's **interval**, differences are sound, But **Fahrenheit** ratios would only just confound.

With a variable that's **ratio**, zero means there's none. And when it comes to **heart rate**, two's twice as much as one!

Examples help us learn what measurement levels are!

An acronym recalls them: It's the French word **NOIR**!

So ordering or averaging **genotype** would really be a shame!

COMPOSER VERSION

00:37

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: **New England Patriots**

2. The margin of error for a **sample proportion** for a survey of 1000 people would be about **3%**. **Hint**

A typical margin of error uses 95% confidence. Your answer is too high for that. See the 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 **14%** and as high as **20%**.

4. If you multiplied the **sample size** by a factor of nine, that would **halve** the **margin of error** by a factor of **3**.

Continue

Height of Confidence

A pollster changes the sample size (n), and confidence level from time to time in a series of polls on the same topic. Put these confidence intervals in order from widest to narrowest:

Categories:

- the widest interval
- the second widest interval
- the third widest (or second narrowest) interval
- the narrowest interval

1. Widest interval

Choices (dropdown menu presented in random order to each student):

A. $n = 100$ with 99% confidence

B. $n = 500$ with 80% confidence

C. $n = 100$ with 95% confidence

D. $n = 500$ with 95% confidence

Answer: A

2. Second widest interval

A. $n = 100$ with 99% confidence

B. $n = 500$ with 80% confidence

C. $n = 100$ with 95% confidence

D. $n = 500$ with 95% confidence

Answer: C

3. Third widest (or second narrowest) interval

A. $n = 100$ with 99% confidence

B. $n = 500$ with 80% confidence

C. $n = 100$ with 95% confidence

D. $n = 500$ with 95% confidence

Answer: D

4. Narrowest interval

A. $n = 100$ with 99% confidence

B. $n = 500$ with 80% confidence

C. $n = 100$ with 95% confidence

D. $n = 500$ with 95% confidence

Answer: B

The screenshots above and to the left show a song's pre-song prompts interface and the playback interface (with student inserts highlighted).

The screenshot above shows another song's prompts interface, which has an example of machine-generated feedback and a hint button. The screenshot to the right shows a song's matching assessment item.

Acknowledgements. This work is supported by the U.S. National Science Foundation grants #1544426, #154437, and #1544243. We are also grateful for the many contributions from other members of our team (see: www.CAUSEweb.org/smiles/team)

REFERENCES

Crowther, G.J. (2016). Educating with music: Relevant reading. <http://singaboutscience.org/wp/educating/research>

Crowther, G., McFadden, T., Fleming, J. & David, K. (2016). Leveraging the power of music to improve science education. *International Journal of Science Education*, 38(1), 73-95.

Lesser, L. (2014). Mathematical lyrics: Noteworthy endeavours in science education. *Journal of Mathematics and the Arts*, 8(1-2), 46-53.

Lesser, L.M., Pearl, D.K., & Weber, J.J. (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.