

Tunes in the Zoom Room: Remote Learning via Videoconference Discussions of Physiology Songs[†]

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As most instruction has been forced online, biology instructors have become acutely aware of the many advantages and limitations of online teaching. Here, we investigate one possible advantage of online education: the ease of allowing remote guest speakers to interact with students in real time. In particular, we piloted a model in which guest speakers could facilitate direct music-related interactions with students, possibly benefiting students' content knowledge and sense of community. In the context of an undergraduate animal physiology course, face-to-face lessons on arterial blood gases and the renal system were supplemented with videoconferences with a guest speaker who presented relevant content-rich songs and led class discussions of the lyrics. Survey and test data suggested that, after each of the lessons, the students (i) had increased confidence in their understanding of the material, (ii) performed better on objective test questions, and (iii) attributed their learning chiefly to the musical intervention. While our approach awaits further exploration and testing, this report provides preliminary evidence of its feasibility and offers practical suggestions for others who may wish to give it a try.

INTRODUCTION

Among the many challenges of online education, one of the most critical is the challenge of creating community. Compared with face-to-face courses, online courses may be less conducive to forging student–student and student–instructor connections (1, 2). General strategies for fostering an inclusive learning community include enabling true dialogue, i.e., the sharing of genuine personal thoughts without fear, and strong ties, i.e., bonds often based on shared interests beyond the course material itself (3). True dialogue and strong ties, in turn, are more likely to occur when courses connect to students' personal interests and life experiences (4).

Of the many ways of integrating students' personal interests into biology curricula (5, 6), musical approaches are of special interest to us. Because music is a nearly universal interest (7), incorporating content-rich music into biology courses could potentially lead to community benefits, such as the true dialogue and strong ties emphasized by Elliott et al. (3). Indeed, the Hip-Hop Education movement (widely

known via the hashtag #HipHopEd) explicitly employs music (plus other elements of hip-hop culture, like graffiti art and breakdancing) for such sociocultural purposes, in addition to covering content (8, 9). This movement has been especially prominent in urban middle school and high school classrooms but has also spread to the college level (10). Furthermore, there are now numerous precedents for using content-rich music to teach biology and other STEM subjects (11–18).

One challenge of teaching biology with music is the fact that most biology instructors—including the first author of this study (P.A.H.)—are not inclined to write or perform content-rich songs. However, videoconference technology can facilitate the use of remote guests with relevant expertise to facilitate musical activities with students in real time. As an initial test of this model, the second author (G.J.C.) led two music-based lessons via videoconference in a zoology course taught by the first author. Our experience suggests that this model may also work in other courses with live-streamed components, an increasingly popular course format when in-person instruction must be limited due to a pandemic or for other reasons.

PROCEDURE

Students ($N = 10$) in an undergraduate Animal Physiology course intended for biology majors (Zoology 625) met once a week in person on campus in a 3-hour lecture

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Received: 7 November 2020, Accepted: 7 December 2020, Published: 31 March 2021

[†]Supplemental materials available at <http://asmscience.org/jmbe>

LYRICS

[Biologist sings:]

*All hail the kidneys:**The blood-cleaning kidneys!**The water-saving kidneys!**The urine-making kidneys!**From the glomeruli**To the collecting ducts,**They turn the flow from red to gold!*

[Patient sings:]

*I've got to pee so bad,**And I'm wondering, "Why is that?"**I suspect three sites**Could be where the problem's at.**Is my hypothalamus off?**Or have my aquaporins all died?**Or should I try**Taking less furosemide?***STUDY QUESTIONS**

Are cleaning blood, saving water, and making urine 3 distinct processes, or are they all basically the same thing? *Bloom: Analysis.*

Why are glomeruli and collecting ducts mentioned in the same breath? *Bloom: Comprehension.*

What is the significance of these colors? *Bloom: Knowledge.*

Which site is the most likely to blame? *Why? Bloom: Analysis.*

How could a hypothalamus malfunction lead to excessive urination? (At least 2 possibilities.) *Bloom: Application.*

How could defective aquaporins lead to excessive urination? *Bloom: Application.*

How does furosemide increase urination? *Bloom: Application.*

FIGURE 1. An example of using a song ("Henle's Water Music"; tinyurl.com/henle-song) as a springboard to discussing biology content. Each discussion question was assigned a level of Bloom's taxonomy as described by Crowe et al. (25).

format. Several weeks of the 13-week course were set up for flipped teaching (19), i.e., readings and videos were assigned as homework but not extensively reviewed in class so that more class time could be devoted to active learning activities. These "flipped weeks" included weeks 7 and 8, the period of this study.

In weeks 7 and 8, the first 30 minutes of the in-person class meeting were devoted to the following: (i) The students took a pre-test on the material to be covered; (ii) Via videoconference, the guest speaker, physically located three time zones away, presented the song of the day ("Gas Exchange Medley" for week 7 and "Henle's Water Music" for week 8) (Appendix 3) and students were encouraged to sing along; (iii) Via videoconference, the guest speaker led a whole-class discussion of questions based on the song (Fig. 1 and Appendices 4 and 5); and (iv) The students took a post-test (which, unlike the pre-test, counted toward the course grade).

The first author's Institutional Review Board approved this study as exempt (IRB application #8005).

RESULTS

This study did not rigorously test the hypothesis that musical activities enhance students' enjoyment and understanding of physiology content. Nevertheless, our pilot data suggest that (i) the blood gas and renal system lessons

increased students' confidence in their knowledge of the material (Appendix 6); (ii) the lessons improved their actual knowledge of this material (Fig. 2); and (iii) these learning gains came mostly from our novel music-related videoconferencing activities, rather than traditional preparatory assignments (Fig. 2).

In explaining the choices shown in Fig. 2, students' free responses focused largely on the use of music (Appendix 7). Notably, several students independently distinguished between the song itself and follow-up discussion of the song, stating in various ways that the meaning of the lyrics was clarified and amplified by the discussion questions (Fig. 1 and Appendices 4 and 5).

DISCUSSION

As a research study, the work reported here had many limitations. Regarding methods, we neglected to ask students whether the musical lessons fostered a sense of community, as we hoped would occur; students' learning gains following our intervention were not compared with gains after non-musical interventions; we relied heavily on students' perceptions of their learning, which can be unreliable (20); and our model was tested only in one 10-student course, so our approach may not be scalable nor our results generalizable. Given these methodological limitations, we cannot be sure whether our students benefited from the songs' novelty,

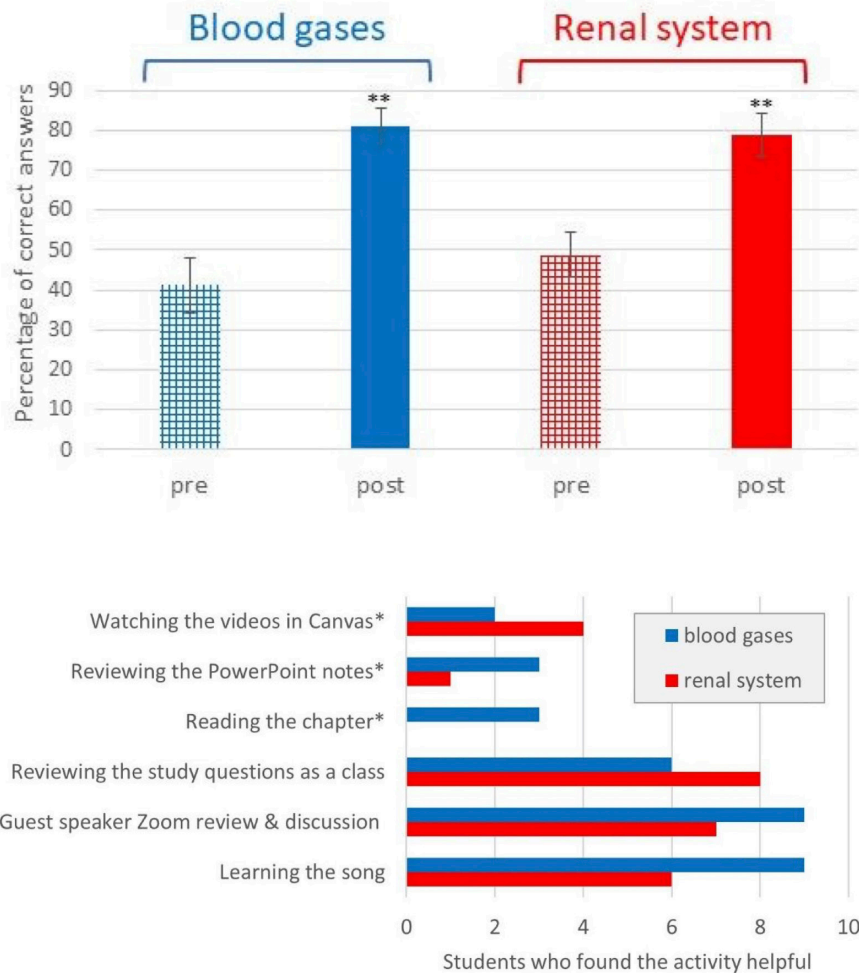


FIGURE 2. Students’ content knowledge improved after musical videoconferences on blood gases ($N = 9$) and the renal system ($N = 8$), and students primarily attributed their learning gains to these videoconferences. (Top panel) Students’ performance on objective multiple-choice questions improved following videoconferences. Values shown are means \pm SEM; double asterisks denote statistically significant differences ($p < 0.01$) between pre-test and post-test scores. (Bottom panel) Students’ responses to the question, “Which of the following helped you understand [topic of the day]?” Students could choose any number of the six options. Activities denoted with an asterisk were assigned prior to the class meeting; the remaining activities were performed as a group during class time. No students found reading the chapter helpful for the renal system lesson.

delivery of content, seeding of fruitful discussions, and/or other aspects.

Despite these caveats, we were pleased that our intervention went smoothly and led to positive student responses. Based on that and other relevant experience (12, 21, 22), we can offer practical encouragement to other instructors who may be tempted to try something similar. The following vignettes illustrate additional ways to incorporate music into a biology course with the aid of a remote guest speaker.

- Example 1: You are teaching a cell biology course in which the translation of mRNA into polypeptides often baffles students. You consult some popular sources of biology songs (Table 1) and discover Kevin Ahern’s song “Good Protein Synthesis” (to the tune of the Christmas song “Good King Wenceslas”). You decide that it would

work well for a group sing-along, but you don’t feel comfortable leading the singing yourself. You enlist a musician friend (not a scientist) to practice the song a few times and then join your live-streamed course to help everyone do the song together.

- Example 2: You offer your students extra credit for writing a song about the material they are studying. A pair of students produce a fantastic disco song about the Hardy-Weinberg equilibrium, which they share with the class. You realize that the rest of the class could also contribute to the song by creating dance moves to visually or kinesthetically illustrate its meaning. Since you and the student songwriters have no expertise in dance, you (with the students’ permission) bring in a colleague from physics, a past participant in the “Dance Your PhD” contest (23). The colleague leads a videoconference ses-

TABLE I.
Selected sources of songs suitable for high school and college biology courses.

Name (position)	Music Website	Note
Kevin Ahern (retired biochemistry lecturer, Oregon State U.)	davincipress.com	Most songs are parodies of “oldies” (e.g., The Beatles)
Rick Bungiro (microbiology & immunology lecturer, Brown Univ.)	youtube.com/c/RickBungiro/	Parodies of new and old hits
Kristin Chavis (independent science educator, Lake Charles, LA)	youtube.com/channel/UCZfYc6rNoxYen2vdZjrHXfw/	Includes hip-hop songs about the body’s organ systems
Greg Crowther (biology instructor, Everett Comm. Coll.)	faculty.washington.edu/crowther/Misc/Songs/	Mostly anatomy and physiology; study questions and karaoke options are included
Arlevia Davis (science teacher, Legacy H.S., Mansfield, TX)	https://www.youtube.com/user/pavefitness	Goes by the alter ego of “Sciyoncé”; songs cover general introductory biology topics
Gary Grossman (ecologist, U. of Georgia)	www.garygrossman.net/natural-voices/	Songs about ecology, evolution, and natural history
Jeremy Long (ecologist, San Diego State U.)	youtube.com/user/iambient33/	Chemical ecology student groups do songs for extra credit
Tom McFadden (science teacher, The Nueva School, California)	sciencewithtom.com	Raps created by students of Tom’s “Rap Academy”
Jeanelle Reid (anatomy & physiology teacher, Cypress Ranch H.S., Texas)	youtube.com/c/MrsReidTheScienceG/	A new YouTube channel as of 2020; includes anatomy and physiology skits as well as songs
Wendy Silk (retired plant biologist, UC-Davis)	youtube.com/user/HearUBEST/	Includes student compositions from the elective course “Earth, Water, Science, and Song”
Carl Winter (retired food scientist, UC-Davis)	youtube.com/user/foodsafetymusic/	Parodies about microbiology and food safety
Glenn Wolkenfeld (biology teacher, Berkeley H.S., California)	sciencemusicvideos.com	AP biology songs with videos, worksheets, etc.

sion in which the students identify some of the lyrics’ key ideas and devise movements to illuminate them.

The common themes of our intervention and these additional examples are that (i) videoconferencing allows “non-musical” biology teachers to include remote guest speakers who lead students in music-related activities in real time, and (ii) most of us have musically inclined friends or family members who might enjoy serving as guest speakers, even if they themselves are not biologists.

As a counterweight to our enthusiasm for musical interventions, we should admit that such interventions do come with several possible pitfalls, which we have enumerated previously (21, 22). These include perceptions that musical activities are a waste of time in a biology class, unclear connections between song lyrics and course content, and unrealistic expectations that a single pass through a song is sufficient for memorization and recall.

In summary, we have described the incorporation of videoconference-based musical interventions into an undergraduate animal physiology course. The students had

no particular expertise in music, nor did they sign up for the course with any expectations that music would be a part of it, yet they responded positively to the intervention. As more and more courses go online, and as students spend less and less time in common physical spaces, music could help stave off “Zoom fatigue” (24) and could catalyze community-building and interactive learning in online educational environments.

ACKNOWLEDGMENTS

This paper reports on an education intervention involving two songs written and performed by the one of the authors (G.J.C.). This author makes these songs and many others freely available on his faculty website, so he does not profit financially from usage of the songs by others. Music videos for some songs are available via the author’s YouTube channel, which has not been monetized in any way. The authors have no conflicts of interest to declare.

SUPPLEMENTAL MATERIALS

- Appendix 1: Pre-test and post-test surveys for blood gases
- Appendix 2: Pre-test and post-test surveys for renal system
- Appendix 3: Content-rich songs used in this study
- Appendix 4: Discussion questions based on the blood gases song
- Appendix 5: Discussion questions based on the renal system song
- Appendix 6: Students' confidence in their content knowledge before and after video-conferences with the guest speaker
- Appendix 7: Students' comments on activities that helped them learn about blood gases

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